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-	1	6149438.pn.	USPAT; US-PGPUB	2004/05/28 10:27
-	1	5960403.pn.	USPAT; US-PGPUB	2004/05/28 10:27

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United States Patent [19]

Richard et al.

[11] Patent Number: 6,149,438

[45] Date of Patent: *Nov. 21, 2000

[54] **SYSTEM AND METHOD FOR THE DELIVERY, AUTHORING, AND MANAGEMENT OF COURSEWARE OVER A COMPUTER NETWORK**

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[73] Assignee: **Texas Instruments Incorporated**, Dallas, Tex.

[*] Notice: This patent is subject to a terminal disclaimer.

[21] Appl. No.: **08/473,616**

[22] Filed: **Jun. 7, 1995**

Related U.S. Application Data

[63] Continuation of application No. 07/742,974, Aug. 9, 1991.

[51] **Int. Cl.**[7] **G09B 5/14**

[52] **U.S. Cl.** **434/322**; 434/323; 434/335; 434/336; 434/362

[58] **Field of Search** 434/118, 322, 434/323, 335, 336, 350, 362

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Primary Examiner—Jessica J. Harrison

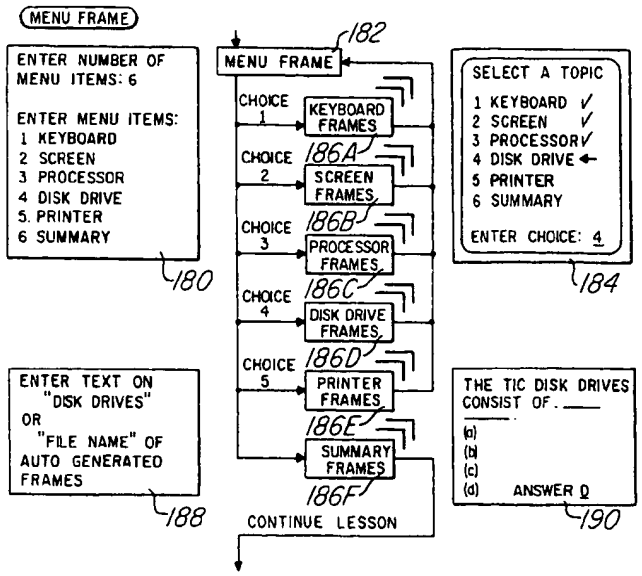
Attorney, Agent, or Firm—W. Daniel Swayze, Jr.; W. James Brady, III; Frederick J. Telecky, Jr.

[57] **ABSTRACT**

A network system for computer aided instruction, comprises a main computer with a repository for storing courseware, a network of servers connected to the main computer, a number of local area networks, each connected to a server, and each comprising a number of interconnected workstations, a distributed delivery system responsive to a student's request for a course, operable to search the network for a server where the requested course resides, and operable to retrieve the course from the repository, and an authoring system distributed over the workstation, the servers and the main computer, and operable to transfer courses from a workstation to the repository, and a course management system distributed over the workstation, the servers and the main computer, and operable to manage course enrollment and to monitor student performance at said servers, and further operable to transfer information concerning course enrollment from said servers to said main computer.

A computer program having provisions for training users in its use, comprises application code, hook points connected to the application code, and embedded training routines connected to the hook points, so that there is a mapping between the hook points and the embedded training routines. The application code has code responsive to a user action to transfer control from the hook points to the embedded training routines.

11 Claims, 14 Drawing Sheets



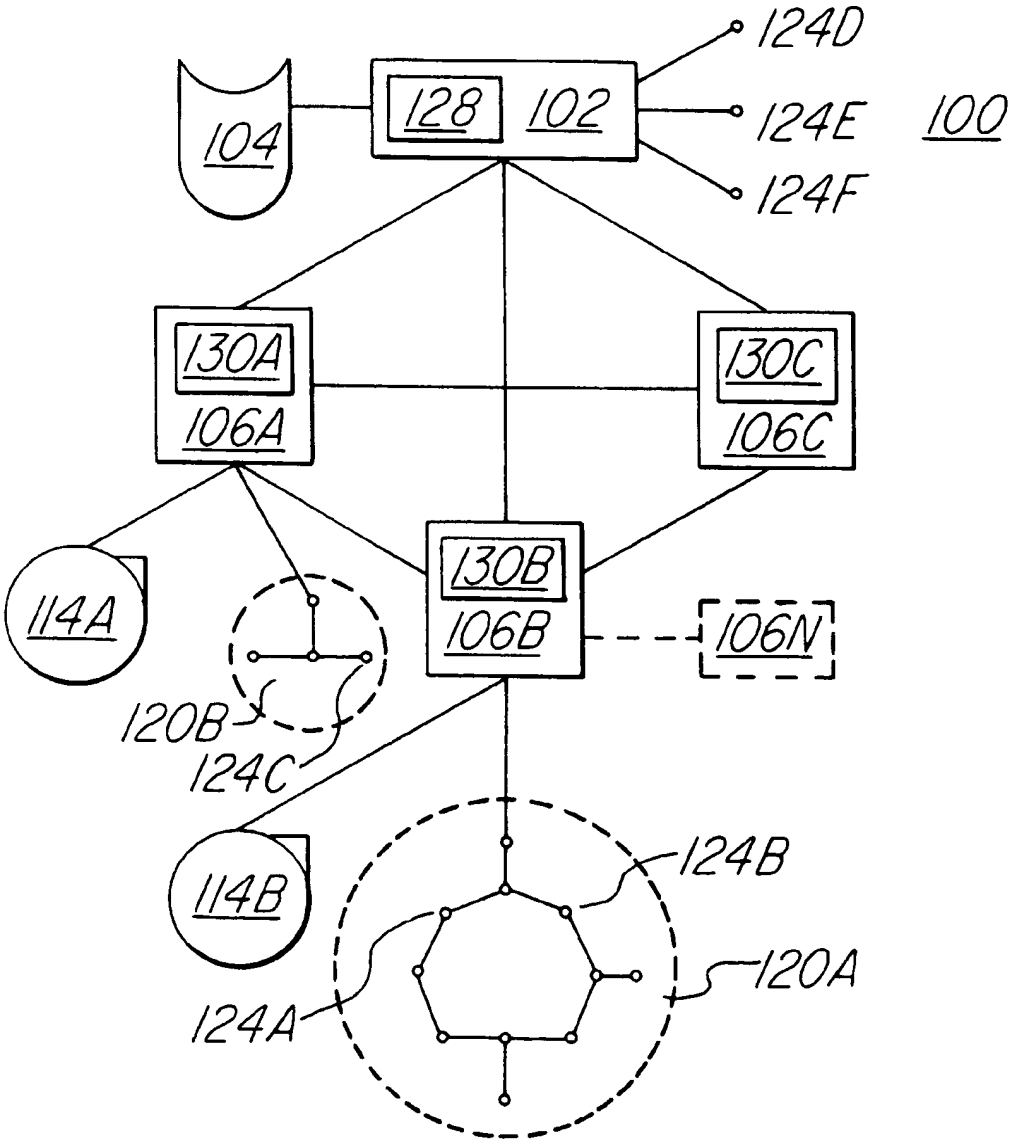

124D
128
102
104
124E
100
124F
130A
106A
130C
106C
130B
106B
106N
114A
120B
124C
114B
124B
120A
124A

FIG. 1

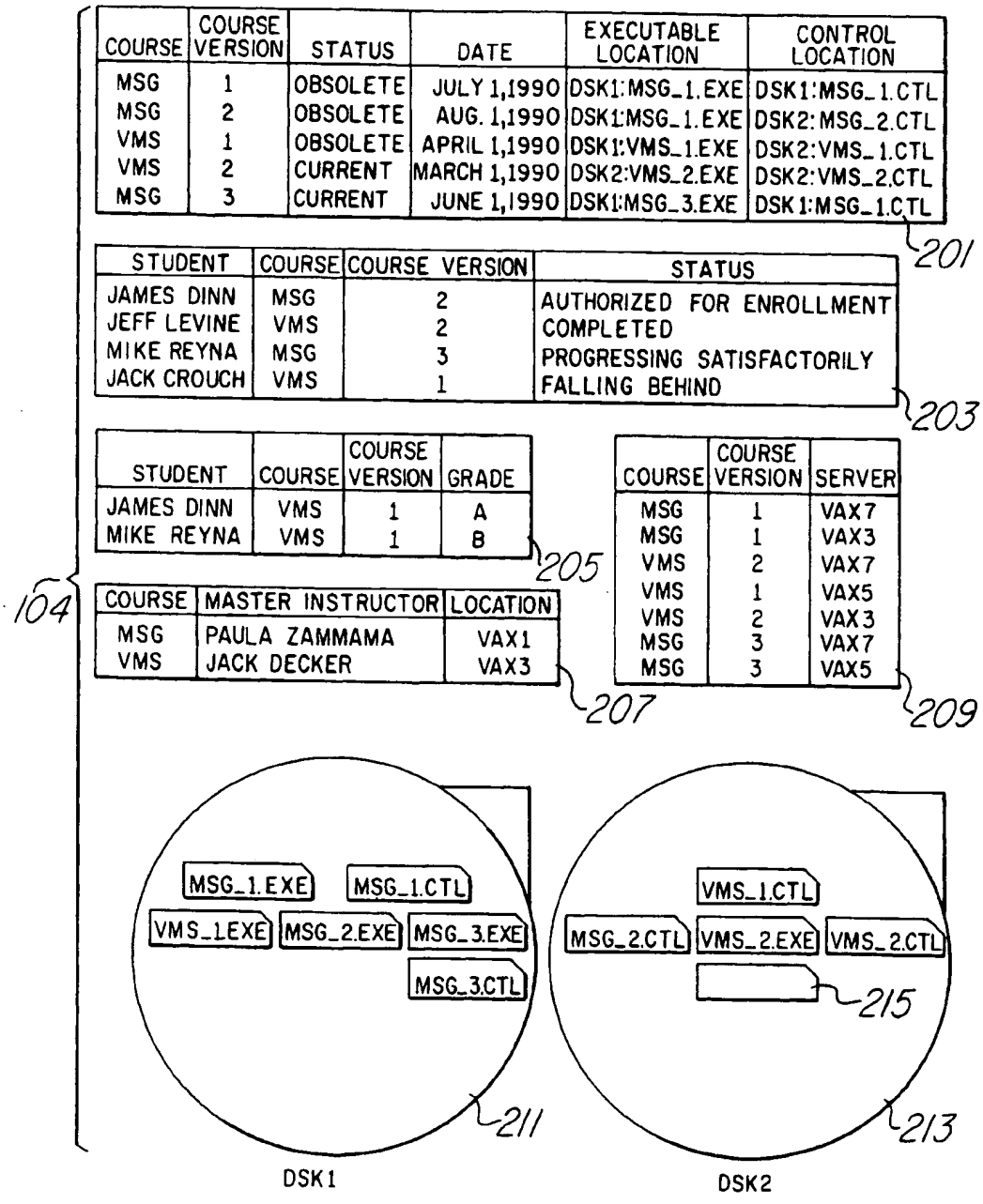

COURSE | COURSE VERSION | STATUS | DATE | EXECUTABLE LOCATION | CONTROL LOCATION
MSG | 1 | OBSOLETE | JULY 1,1990 | DSK1:MSG_1.EXE | DSK1:MSG_1.CTL
MSG | 2 | OBSOLETE | AUG. 1,1990 | DSK1:MSG_1.EXE | DSK2:MSG_2.CTL
VMS | 1 | OBSOLETE | APRIL 1,1990 | DSK1:VMS_1.EXE | DSK2:VMS_1.CTL
VMS | 2 | CURRENT | MARCH 1,1990 | DSK2:VMS_2.EXE | DSK2:VMS_2.CTL
MSG | 3 | CURRENT | JUNE 1,1990 | DSK1:MSG_3.EXE | DSK1:MSG_1.CTL
201
STUDENT | COURSE | COURSE VERSION | STATUS
JAMES DINN | MSG | 2 | AUTHORIZED FOR ENROLLMENT
JEFF LEVINE | VMS | 2 | COMPLETED
MIKE REYNA | MSG | 3 | PROGRESSING SATISFACTORILY
JACK CROUCH | VMS | 1 | FALLING BEHIND
203
STUDENT | COURSE | COURSE VERSION | GRADE
JAMES DINN | VMS | 1 | A
MIKE REYNA | VMS | 1 | B
205
COURSE | COURSE VERSION | SERVER
MSG | 1 | VAX7
MSG | 1 | VAX3
VMS | 2 | VAX7
VMS | 1 | VAX5
VMS | 2 | VAX3
MSG | 3 | VAX7
MSG | 3 | VAX5
209
104
COURSE | MASTER INSTRUCTOR | LOCATION
MSG | PAULA ZAMMAMA | VAX1
VMS | JACK DECKER | VAX3
207
MSG_1.EXE
MSG_1.CTL
VMS_1.EXE
MSG_2.EXE
MSG_3.EXE
MSG_3.CTL
211
DSK1
VMS_1.CTL
MSG_2.CTL
VMS_2.EXE
VMS_2.CTL
215
213
DSK2

FIG. 2

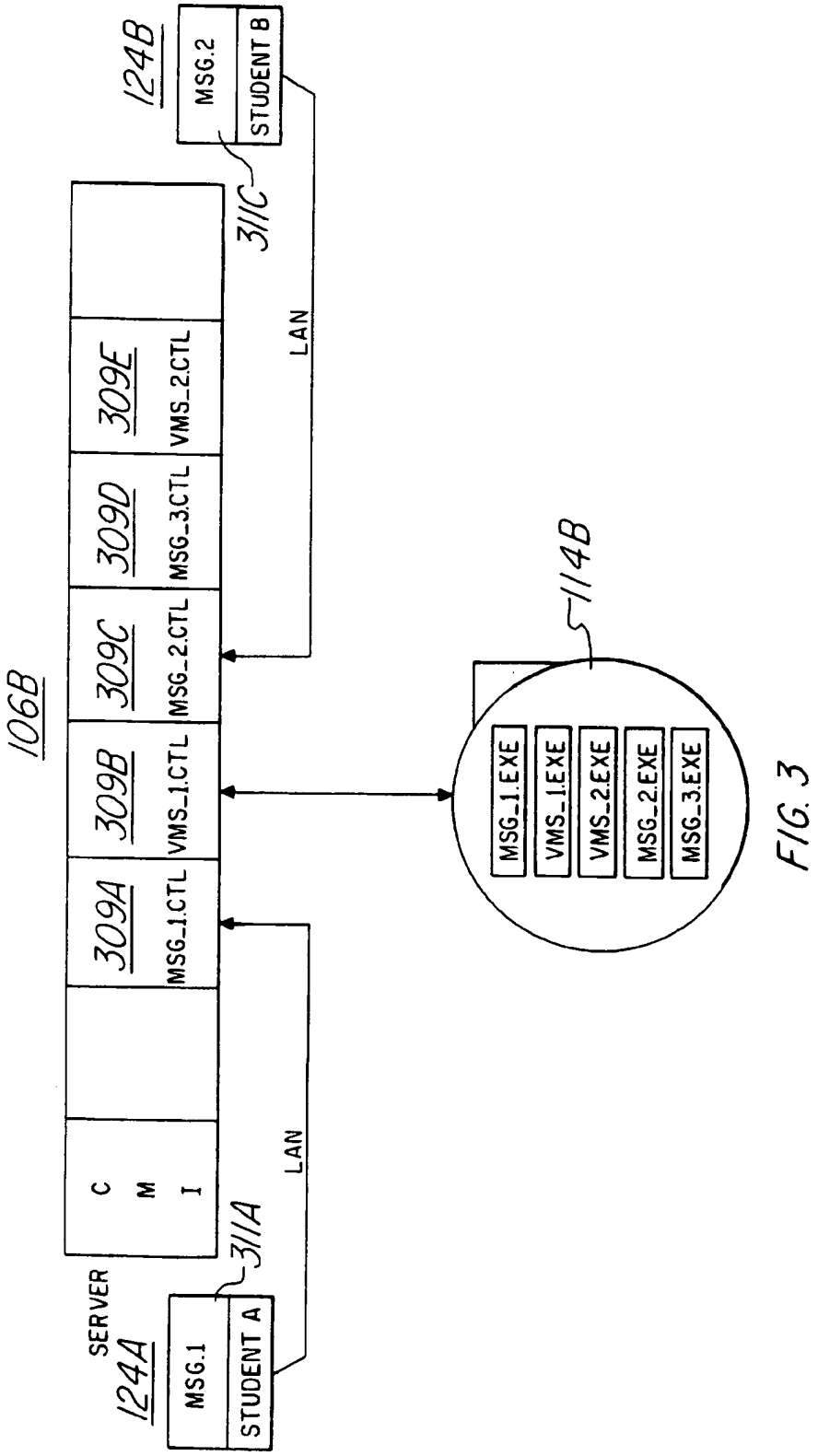

106B
SERVER
124A
MSG.1
STUDENT A
311A
LAN
C
M
I
309A
MSG_1.CTL
309B
VMS_1.CTL
309C
MSG_2.CTL
309D
MSG_3.CTL
309E
VMS_2.CTL
LAN
311C
124B
MSG.2
STUDENT B
114B
MSG_1.EXE
VMS_1.EXE
VMS_2.EXE
MSG_2.EXE
MSG_3.EXE

FIG. 3

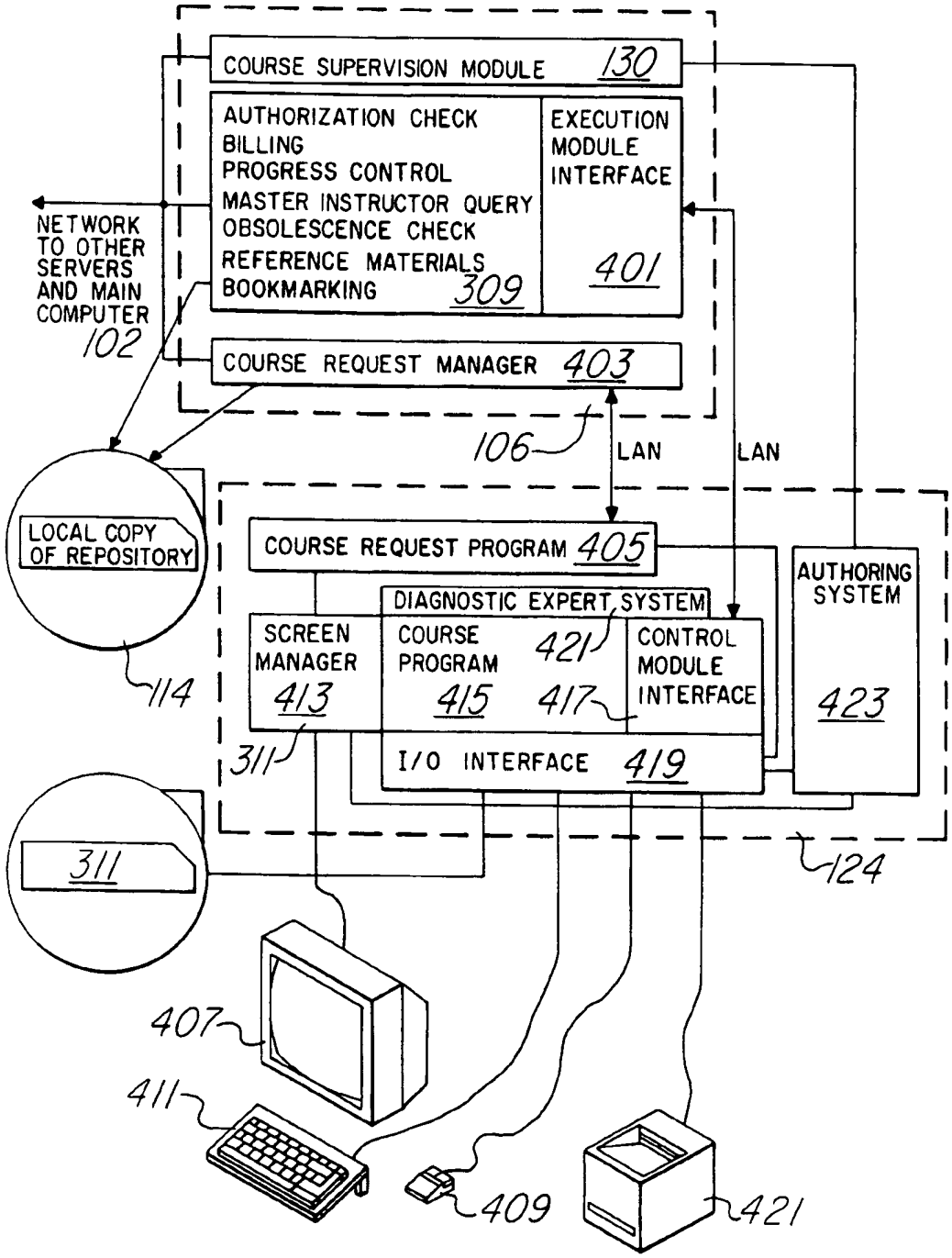

COURSE SUPERVISION MODULE 130
AUTHORIZATION CHECK
BILLING
PROGRESS CONTROL
MASTER INSTRUCTOR QUERY
OBSOLESCENCE CHECK
REFERENCE MATERIALS
BOOKMARKING 309
EXECUTION MODULE INTERFACE 401
NETWORK TO OTHER SERVERS AND MAIN COMPUTER 102
COURSE REQUEST MANAGER 403
106
LAN
LAN
LOCAL COPY OF REPOSITORY
114
COURSE REQUEST PROGRAM 405
DIAGNOSTIC EXPERT SYSTEM
SCREEN MANAGER 413
COURSE PROGRAM 415
421
CONTROL MODULE INTERFACE 417
AUTHORING SYSTEM 423
311
I/O INTERFACE 419
311
124
407
411
409
421

FIG. 4

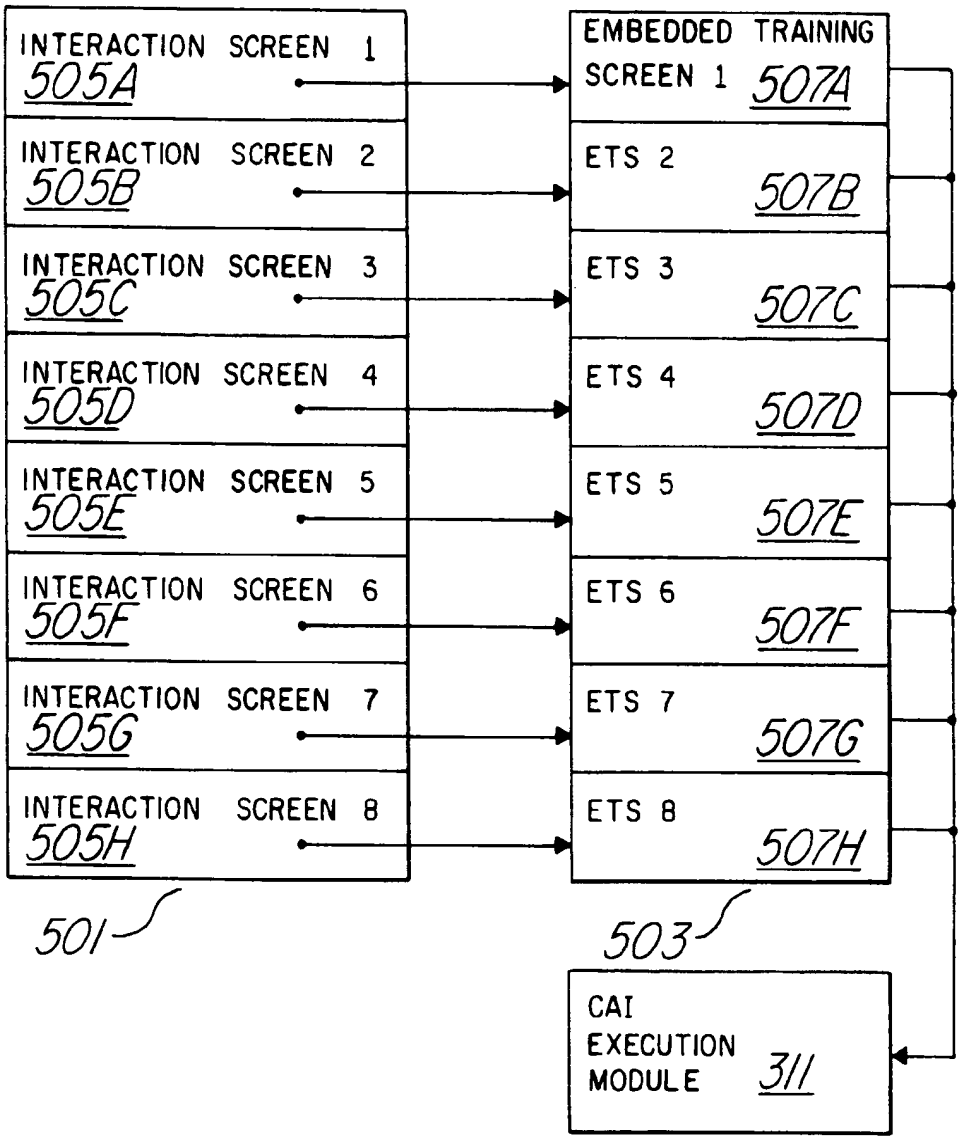

INTERACTION SCREEN 1
505A
INTERACTION SCREEN 2
505B
INTERACTION SCREEN 3
505C
INTERACTION SCREEN 4
505D
INTERACTION SCREEN 5
505E
INTERACTION SCREEN 6
505F
INTERACTION SCREEN 7
505G
INTERACTION SCREEN 8
505H
501
EMBEDDED TRAINING SCREEN 1
507A
ETS 2
507B
ETS 3
507C
ETS 4
507D
ETS 5
507E
ETS 6
507F
ETS 7
507G
ETS 8
507H
503
CAI EXECUTION MODULE
311

FIG. 5

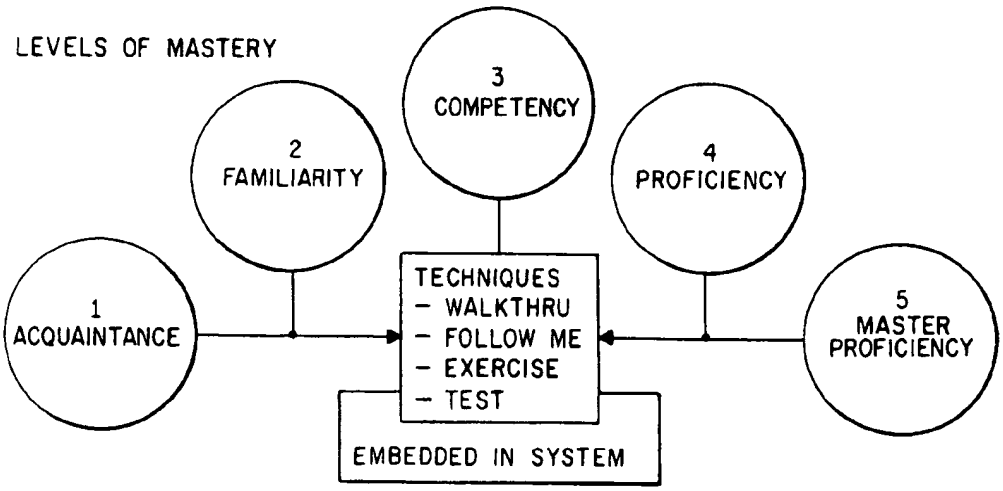


FIG. 6

RULE 801	GOTO 803	ADDRESS 805
807 ON SCREEN 10 AND INCORRECT ANSWER TO QUERY 2 REPEATED 5 TIMES	SCREEN 27	AF00 1E08
809 DOING DIRECTORY COMMAND AND REPEATEDLY ENTERS INCORRECT FILE SPECIFICATION	SCREEN 4 OF FILE SPECIFICATION	AF00 11EFF
811 DOING VMS BEGINNERS COURSE AND HAS ANSWERED THE LAST 20 QUESTIONS CORRECTLY	GOTO SCREEN 1 OF INTERMEDIATE COURSE	AF01 00E5

FIG. 8

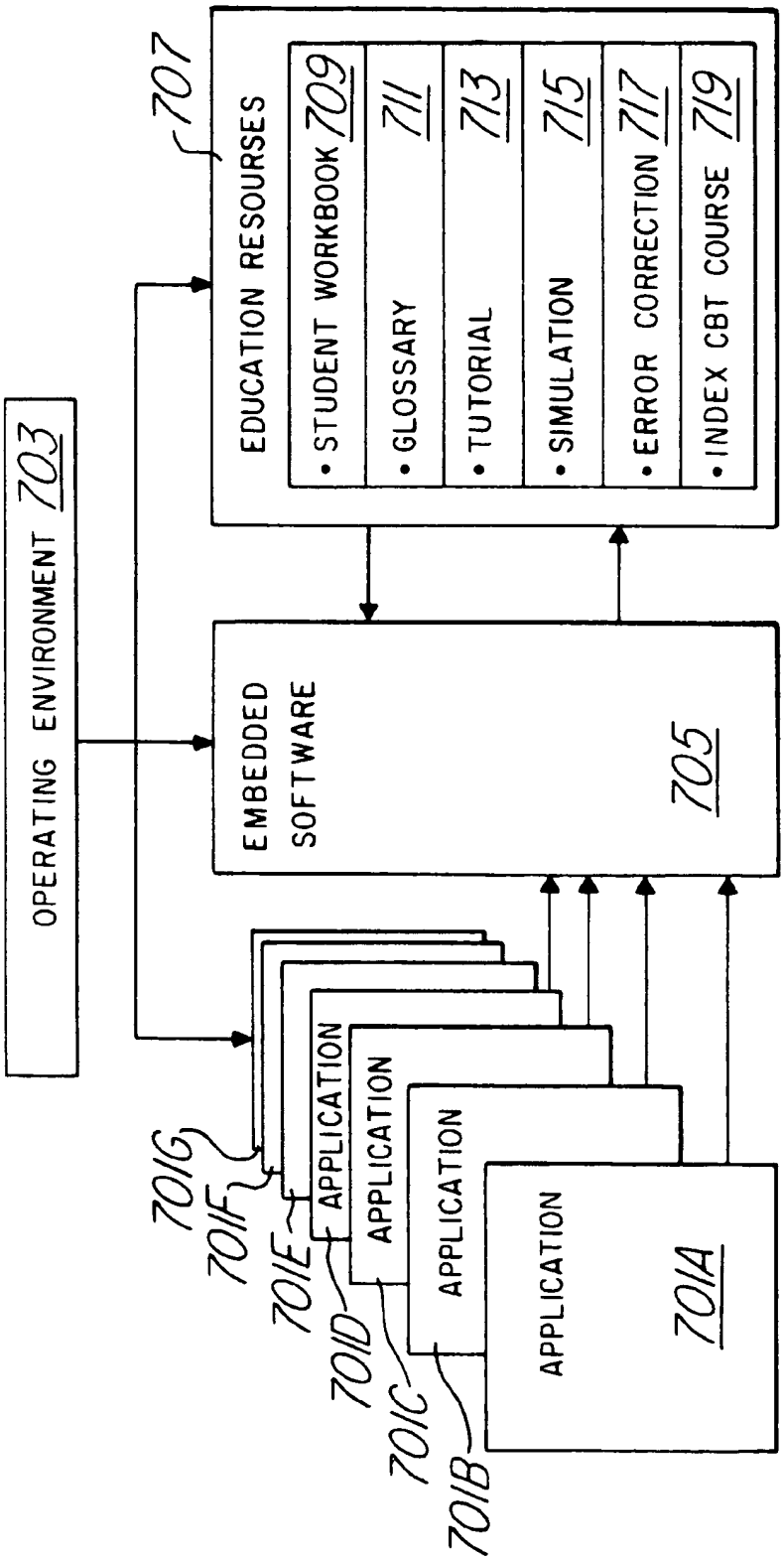

OPERATING ENVIRONMENT 703
EDUCATION RESOURSES 707
• STUDENT WORKBOOK 709
• GLOSSARY 711
• TUTORIAL 713
• SIMULATION 715
• ERROR CORRECTION 717
• INDEX CBT COURSE 719
EMBEDDED SOFTWARE 705
APPLICATION 701A
APPLICATION 701B
APPLICATION 701C
APPLICATION 701D
APPLICATION 701E
701F
701G

FIG. 7

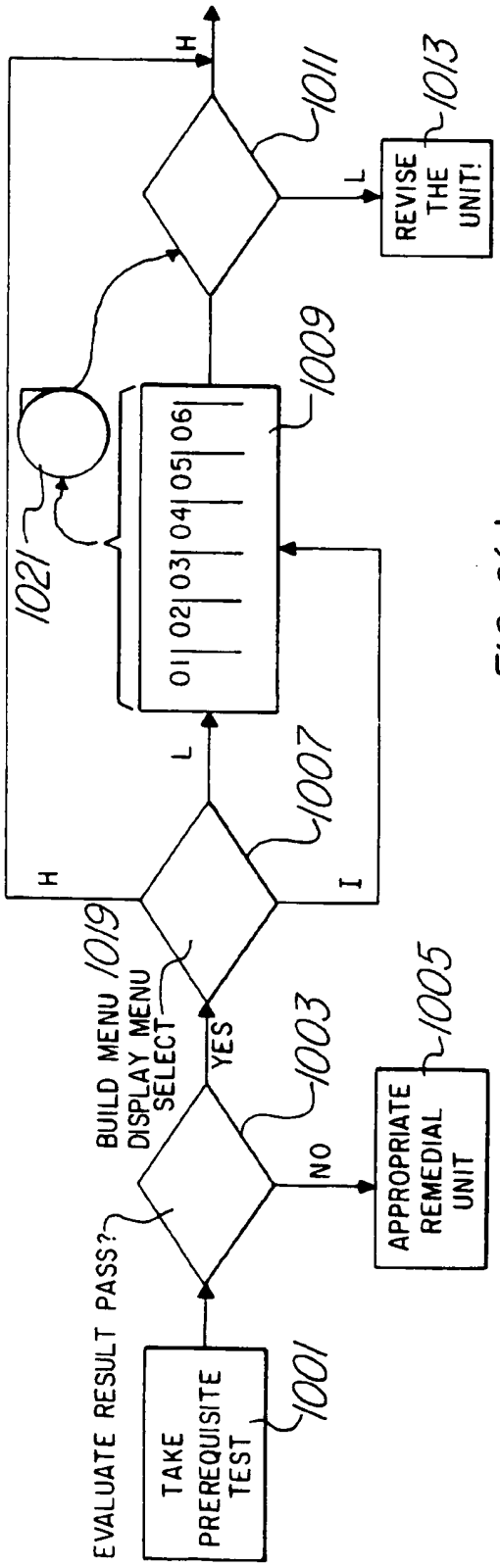

TAKE PREREQUISITE TEST
1001
EVALUATE RESULT PASS?
1003
NO
APPROPRIATE REMEDIAL UNIT
1005
YES
BUILD MENU DISPLAY MENU SELECT
1019
H
L
1007
01 02 03 04 05 06
1009
1021
H
L
1011
REVISE THE UNIT!
1013

FIG. 9(a)

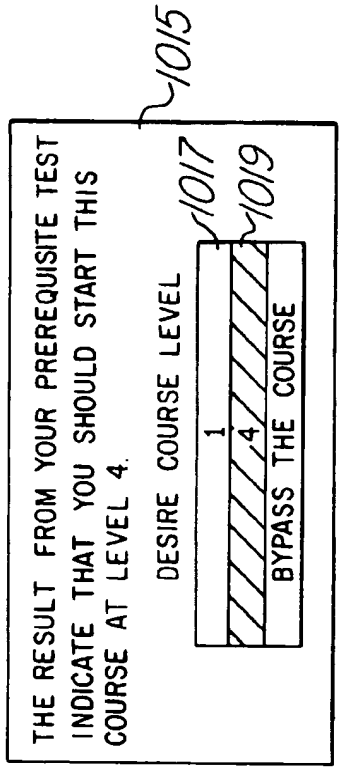

THE RESULT FROM YOUR PREREQUISITE TEST INDICATE THAT YOU SHOULD START THIS COURSE AT LEVEL 4.
1015
DESIRE COURSE LEVEL
1017
1
4
1019
BYPASS THE COURSE

FIG. 9(b)

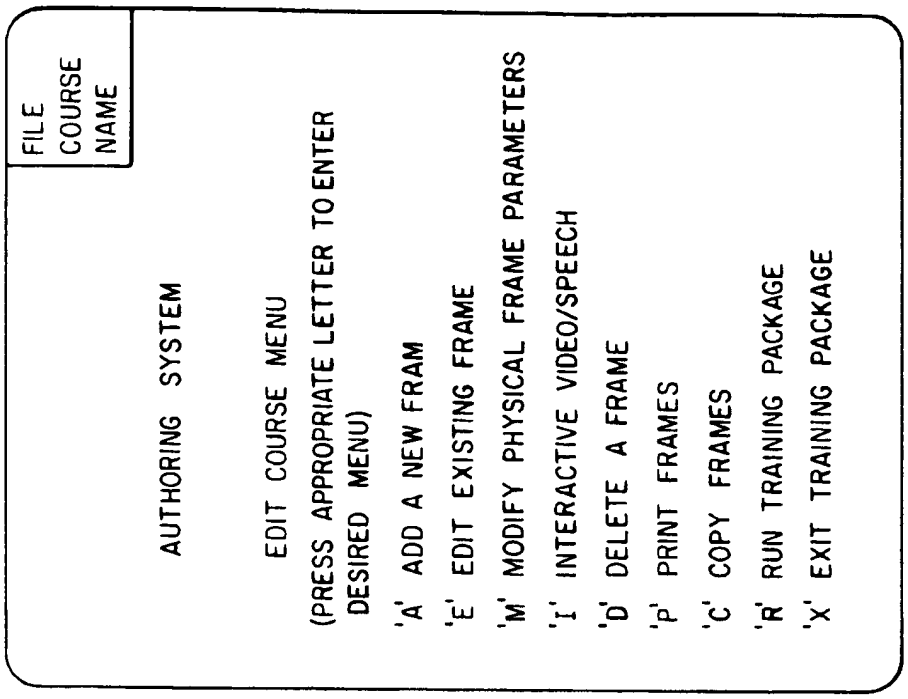


FIG. 10(b)

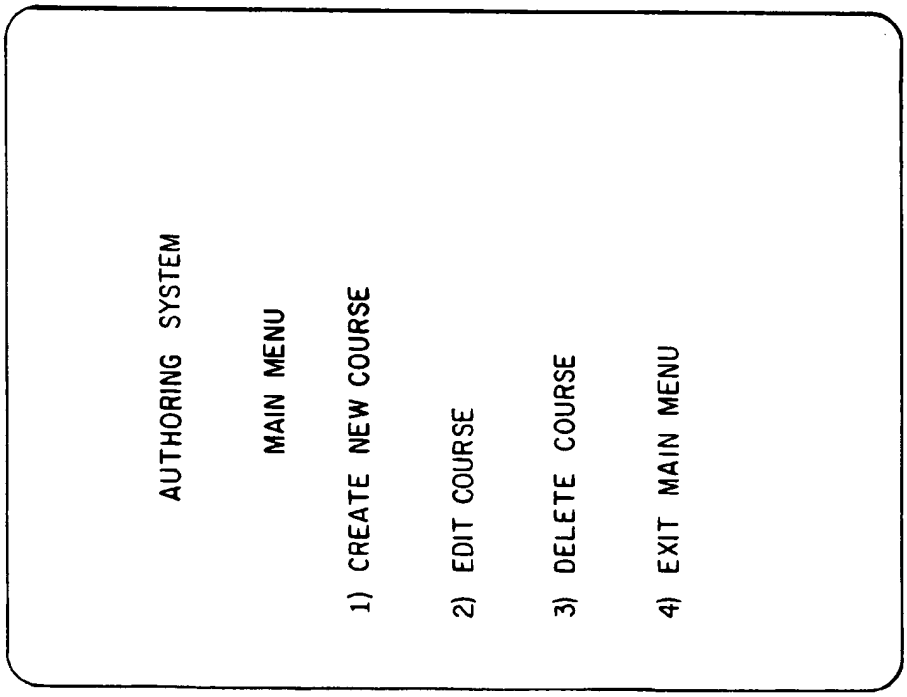


FIG. 10(a)

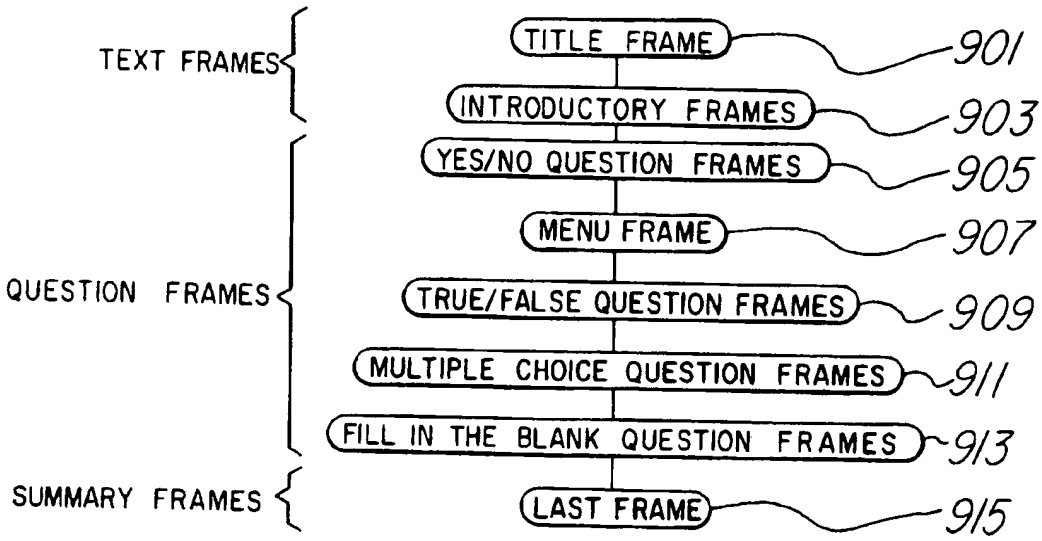

TEXT FRAMES
QUESTION FRAMES
SUMMARY FRAMES
TITLE FRAME
901
INTRODUCTORY FRAMES
903
YES/NO QUESTION FRAMES
905
MENU FRAME
907
TRUE/FALSE QUESTION FRAMES
909
MULTIPLE CHOICE QUESTION FRAMES
911
FILL IN THE BLANK QUESTION FRAMES
913
LAST FRAME
915

FIG. 10(c)

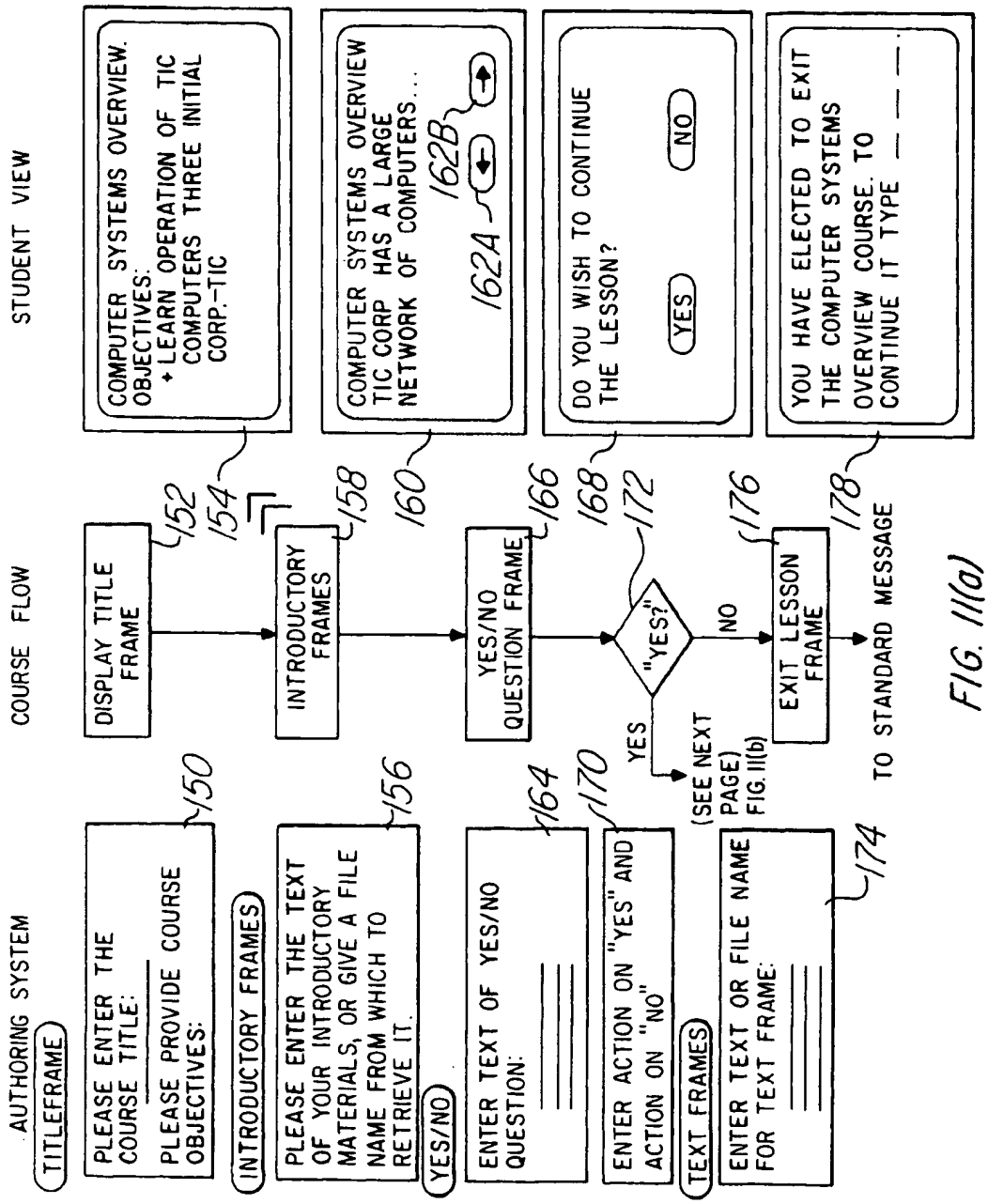

AUTHORING SYSTEM
COURSE FLOW
STUDENT VIEW
TITLEFRAME
PLEASE ENTER THE COURSE TITLE:
PLEASE PROVIDE COURSE OBJECTIVES:
150
INTRODUCTORY FRAMES
PLEASE ENTER THE TEXT OF YOUR INTRODUCTORY MATERIALS, OR GIVE A FILE NAME FROM WHICH TO RETRIEVE IT.
156
YES/NO
ENTER TEXT OF YES/NO QUESTION:
164
ENTER ACTION ON "YES" AND ACTION ON "NO"
170
TEXT FRAMES
ENTER TEXT OR FILE NAME FOR TEXT FRAME:
174
DISPLAY TITLE FRAME
152
154
COMPUTER SYSTEMS OVERVIEW. OBJECTIVES:
• LEARN OPERATION OF TIC COMPUTERS THREE INITIAL CORP.-TIC
INTRODUCTORY FRAMES
158
COMPUTER SYSTEMS OVERVIEW TIC CORP HAS A LARGE NETWORK OF COMPUTERS...
162B
162A
160
YES/NO QUESTION FRAME
166
DO YOU WISH TO CONTINUE THE LESSON?
YES
NO
168
"YES?"
172
YES
(SEE NEXT PAGE) FIG. II(b)
NO
176
EXIT LESSON FRAME
YOU HAVE ELECTED TO EXIT THE COMPUTER SYSTEMS OVERVIEW COURSE. TO CONTINUE IT TYPE
178
TO STANDARD MESSAGE

FIG. II(a)

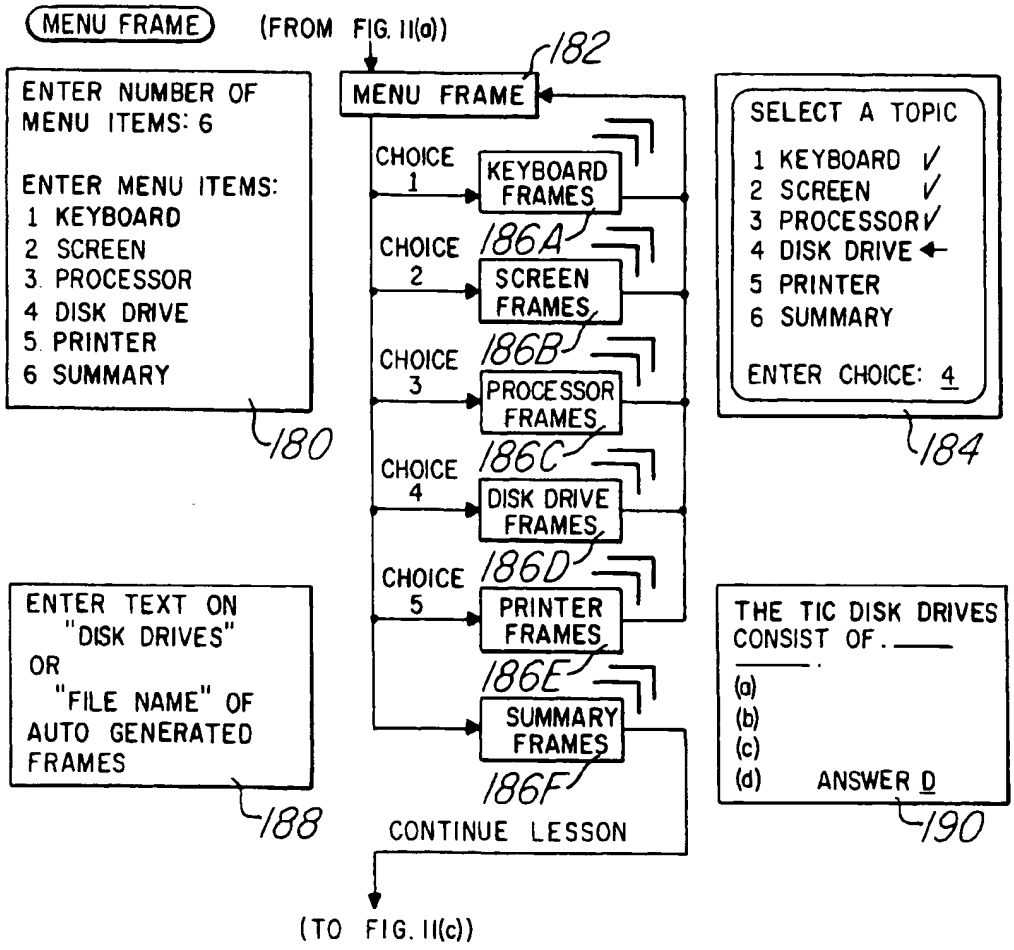

MENU FRAME
(FROM FIG. 11(a))
182
MENU FRAME
ENTER NUMBER OF MENU ITEMS: 6
ENTER MENU ITEMS:
1 KEYBOARD
2 SCREEN
3 PROCESSOR
4 DISK DRIVE
5 PRINTER
6 SUMMARY
180
CHOICE 1
KEYBOARD FRAMES
186A
CHOICE 2
SCREEN FRAMES
186B
CHOICE 3
PROCESSOR FRAMES
186C
CHOICE 4
DISK DRIVE FRAMES
186D
CHOICE 5
PRINTER FRAMES
186E
SUMMARY FRAMES
186F
CONTINUE LESSON
SELECT A TOPIC
1 KEYBOARD ✓
2 SCREEN ✓
3 PROCESSOR ✓
4 DISK DRIVE ←
5 PRINTER
6 SUMMARY
ENTER CHOICE: 4
184
ENTER TEXT ON "DISK DRIVES" OR "FILE NAME" OF AUTO GENERATED FRAMES
188
THE TIC DISK DRIVES CONSIST OF. ____
(a)
(b)
(c)
(d) ANSWER D
190
(TO FIG. 11(c))

FIG. 11(b)

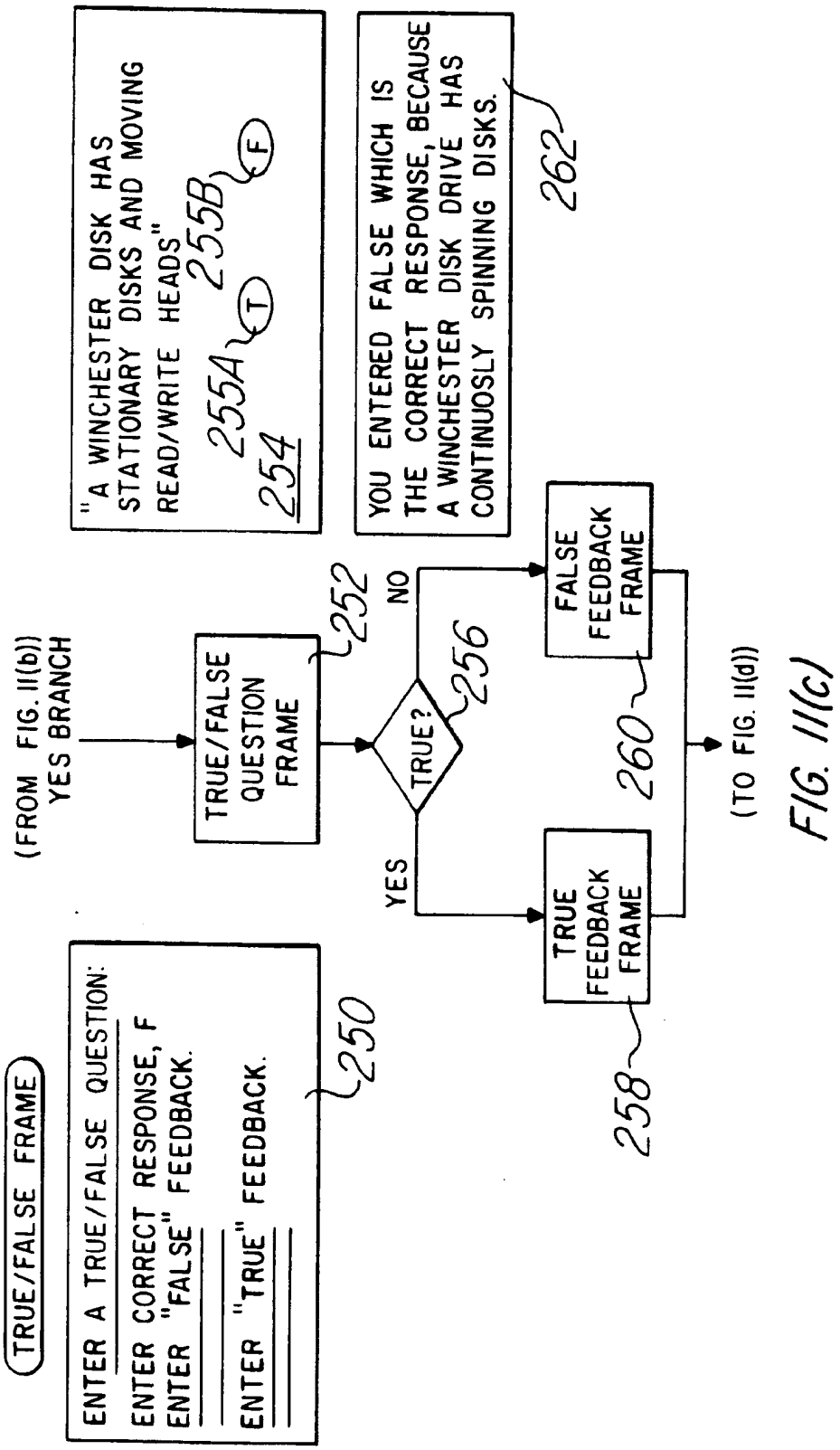

TRUE/FALSE FRAME
ENTER A TRUE/FALSE QUESTION:
ENTER CORRECT RESPONSE, F
ENTER "FALSE" FEEDBACK.
ENTER "TRUE" FEEDBACK.
250
(FROM FIG. II(b))
YES BRANCH
TRUE/FALSE QUESTION FRAME
252
TRUE?
256
NO
YES
FALSE FEEDBACK FRAME
TRUE FEEDBACK FRAME
260
258
(TO FIG. II(d))
"A WINCHESTER DISK HAS STATIONARY DISKS AND MOVING READ/WRITE HEADS"
254
255A
T
255B
F
YOU ENTERED FALSE WHICH IS THE CORRECT RESPONSE, BECAUSE A WINCHESTER DISK DRIVE HAS CONTINUOSLY SPINNING DISKS.
262

FIG. II(c)

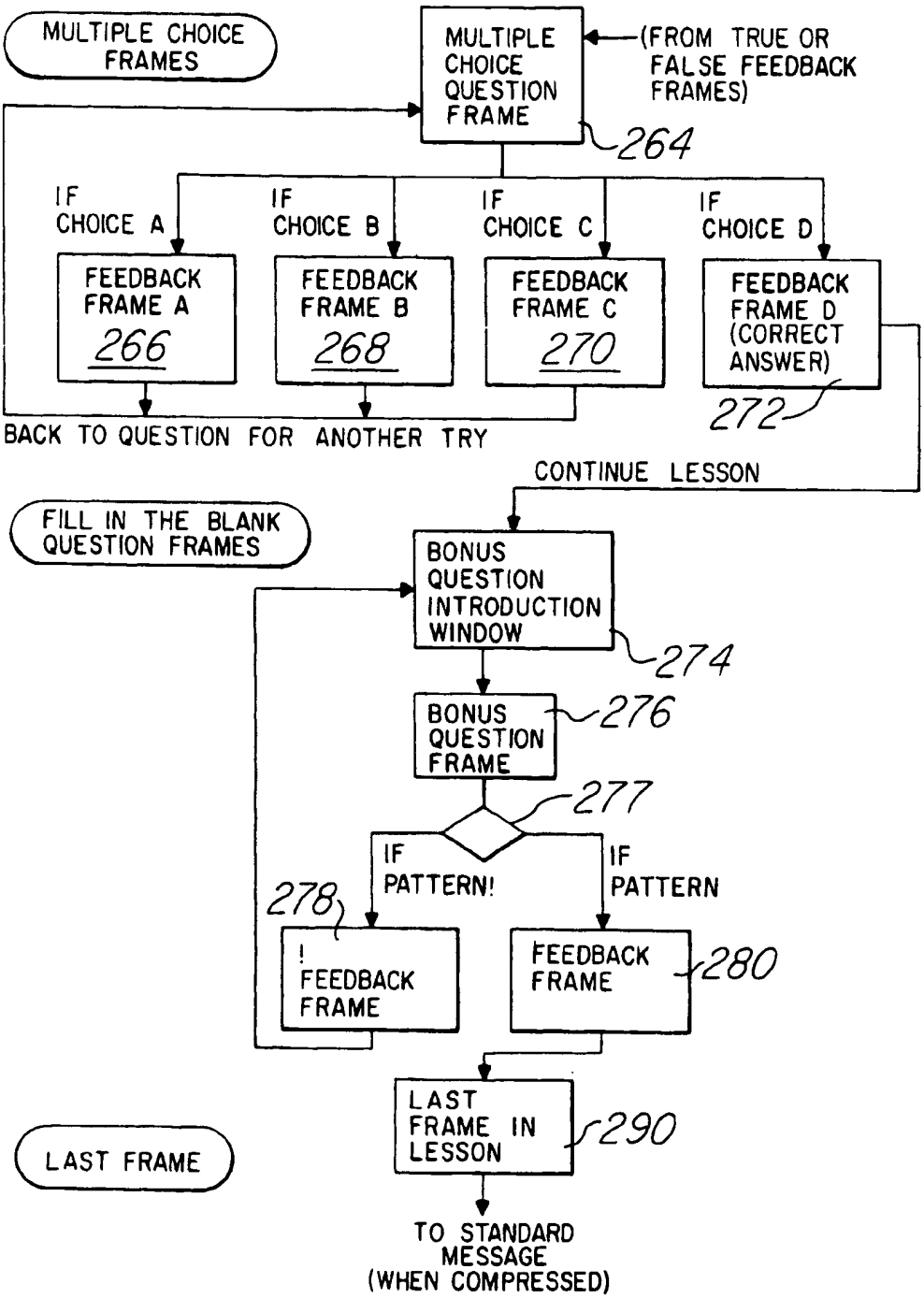

MULTIPLE CHOICE FRAMES
MULTIPLE CHOICE QUESTION FRAME
(FROM TRUE OR FALSE FEEDBACK FRAMES)
264
IF CHOICE A
IF CHOICE B
IF CHOICE C
IF CHOICE D
FEEDBACK FRAME A
266
FEEDBACK FRAME B
268
FEEDBACK FRAME C
270
FEEDBACK FRAME D (CORRECT ANSWER)
272
BACK TO QUESTION FOR ANOTHER TRY
CONTINUE LESSON
FILL IN THE BLANK QUESTION FRAMES
BONUS QUESTION INTRODUCTION WINDOW
274
BONUS QUESTION FRAME
276
277
IF PATTERN!
IF PATTERN
278
! FEEDBACK FRAME
FEEDBACK FRAME
280
LAST FRAME IN LESSON
290
LAST FRAME
TO STANDARD MESSAGE (WHEN COMPRESSED)

FIG. 11(d)

SYSTEM AND METHOD FOR THE DELIVERY, AUTHORING, AND MANAGEMENT OF COURSEWARE OVER A COMPUTER NETWORK

This is a Continuation of application Ser. No. 07/742,974, filed Aug. 9, 1991, pending.

NOTICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to computer aided instruction and in particular to a system and method for delivery, authoring, and management of courseware over a computer network.

2. Description of the Related Art

Hitherto Computer Aided Instruction (CAI) has followed two approaches, which may be labelled "the mainframe approach" and "the diskette delivery approach", respectively. Inherent to both are certain problems which make them unattractive for authoring and maintenance of educational materials, e.g., course authoring, course maintenance and course management.

In "the mainframe approach" of CAI the computerized course is a computer program stored and executed on a mainframe computer. This approach requires that each student of a particular course has access to the computer on which the program corresponding to the course resides. However, in many organizations it is not possible for all potential students to have access to a particular mainframe. Another limitation of the "mainframe approach" is that downtime affects all users. Furthermore, if the mainframe computer used for many concurrent tasks, e.g., many students taking many courses simultaneously or the CAI running in parallel with other tasks, then the responsiveness is often impaired. This aspect of "the mainframe approach" negatively effects the quality of the interaction between the courseware and the students.

In the "diskette delivery" approach, courses are delivered on a diskette and are executed by the student on his or her personal workstation. A problem with this approach is that the education administrator loses control over the course. For example, the original recipient of the course diskette may make a copy of the course and give this copy to a colleague without notifying the course administrator. Moreover, the course administrator is unable to monitor student progress and verifying that a student who enrolls in a course actually takes and eventually completes the course.

Losing control over the diskette also results in the course administrator losing control over which version of a course a student is taking. For example, if the student who originally obtains a given course, after finishing it, passes it on to a colleague and in the meantime a new update or a corrected course is released, the colleague would be taking an obsolete version. In case there are problems, e.g., bugs, in the software which constitutes a course, not being able to control which versions are actually used is a serious problem.

Another aspect of computerized training is help facilities, which provide a documentation support to computer programs. These facilities feature a "current screen" oriented user interface. The problems with this approach to training is that a user must both know that he or she has a problem and must know where to look for documentation on the problem.

Furthermore, such systems are limited to being help facilities as opposed to providing user training. Prior art training systems are stand alone programs, which are separate from the application programs to which they provide training. These systems require the user to leave the application program in order to enter the training sequence.

Another problem with prior art training systems is that there is no correlation between the mistakes a user makes in operating a system and the training provided to the user. It is required of the user to know when he or she is making a mistake, and upon realizing a mistake is being made, the user must know where to look for training materials.

Accordingly, improvements which overcome any or all of these problems with existing Computer Aided Training systems are presently desirable.

SUMMARY OF THE INVENTION

A network system for computer aided instruction, comprises a main computer with a repository for storing courseware, a network of servers connected to the main computer, L number of local area networks, each connected to a server, and each comprising a number of interconnected workstations. In this network a distributed delivery system is responsive to a student's request for a course and is operable to search the network for a server where the requested course resides. If the course is not resident on any server the delivery system operates to retrieve the course from the repository.

The network computer aided training system also incorporates a course management system, which also is distributed over the network. It is operable to manage course enrollment and to monitor student performance at the servers and to transfer information concerning course enrollment from the servers to the repository at the main computer.

The network system also has an authoring system which is distributed over the workstation, the servers and the main computer, and is operable to transfer courses from a workstation where the course author works to the repository. The authoring system also provides the course author with tools for automatically generating templates for courses from interviews with subject matter experts and tools for creating various types of interaction screens.

Courses are developed to provide multiple levels of detail ranging from an overview of the subject matter to a high level of detail and comprehensive testing. There are also intermediate levels, for example, one in which detailed information is provided but testing only occurs at the end of each lesson and a relatively low score is considered as "passing."

In one aspect of the invention, computer programs have provisions for training users in its use, comprises application code, hook points connected to the application code, and embedded training routines connected to the hook points, so that there is a mapping between the hook points and the embedded training routines. The application code has code responsive to a user action to transfer control from the hook points to the embedded training routines. Furthermore, the embedded training routines are operable to transfer control to courses which provide a higher level of detail.

It is an object of the invention to manage courseware in a non-exclusive fashion both at a central repository and at servers located throughout a computer network.

It is another object of the invention to enable a student working at a workstation located anywhere in the computer network to request enrollment in courses which may or may not be located at a server connected to the student's workstation.

It is an additional object of the invention to manage the enrollment and to monitor the performance of a student at the server to which the student's workstation is attached, and to transfer the enrollment and performance information from the server to a main repository.

It is a further object of the invention to embed training materials into application programs while allowing the training materials to be located at any server or repository in the network.

It is also an object of the invention to enable course authors to transfer new courses and updates to old courses from their individual workstations into a main repository for courseware from which students may retrieve the courses.

It is an additional object of the invention to allow course managers to be privy to information concerning the courses they manage, e.g., questions which appear to be defective, so that they can use that information in updating the courses which they manage.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a computer network environment in which the invention operates.

FIG. **2** is a database schema and file structure for the preferred embodiment of the networked computer aided instruction system.

FIG. **3** shows the programs operating on a server and two workstations according to the preferred embodiment computer aided instruction system.

FIG. **4** shows internal details of the programs operating on a server and a workstation according to the preferred embodiment.

FIG. **5** shows the preferred embodiment embedded training program.

FIG. **6** shows features of the networked computer aided instruction and embedded training according to the preferred embodiment.

FIG. **7** shows how certain modules of the embedded training according to the preferred embodiment are shared between application programs.

FIG. **8** shows the rule base for the diagnostic expert system of the present invention.

FIGS. **9**(*a*) and **9**(*b*) show the branching options available to a student taking a course implemented according to the preferred embodiment.

FIGS. **10**(*a*), **10**(*b*) and **10**(*c*) show the main menus of the course authoring system of the present invention.

FIGS. **11**(*a*), **11**(*b*), **11**(*c*), and **11**(*d*) show the interaction between the author and the authoring system, the structure of a course created using the authoring system, and the student's view of the course, all according to the preferred embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. **1** is a block diagram of a computer network environment in which the invention operates. In FIG. 1, a main computer **102** is part of a computer network **100**. Repository **104** is connected to main computer **102**. Computer network **100** also consists of a large number of servers, for example servers **106A**, **106B**, and **106C**. Each server may have associated with it some file storage, e.g., disks **114A** and **114B**. The servers are connected to and "serve" local area networks (LAN) **120**. These LANs consist of interconnected workstations, e.g, workstations **124A**, **124B**, and **124C**. Workstations, e.g., **124D**, **124E**, and **124F**, may also be connected directly to main computer **102**. In FIG. **1**, each small circle designates a workstation. In an alternative embodiment, some servers are peer servers, i.e., they are workstations in the same LAN as the workstations they serve.

Typical to large organizations, such as corporations, universities and government agencies, is that computer networks, such as the one depicted in FIG. **1**, consists of hundreds or thousands of computers. These computers may be connected in a myriad of different ways. FIG. **1** shows only one way in which the relatively small number of computers shown there can be connected. A person of ordinary skills in the art will realize that the present invention is in no way dependent on the number of computers in the network or how these computers are connected to one another.

Another typical feature of computer networks is that the types of computers in the network varies widely. Therefore, it is of primordial importance that the computers, which are of differing manufacture, may communicate with each other, and any software products which rely on distributing tasks over the various computers in the network should be so constructed as to make the differences between the various kinds of computers in the network moot. The present invention is cognizant of these problems inherent to computer networks with multiple types of computers.

From the network point of view, main computer **102** may be no different than any other computer in the network. However, from the perspective of the present invention, main computer **102** serves the designated function of managing a central repository **104** of courseware. FIG. **2** is a schematic of repository **104**. It shows a relational database implementation of the database in which course and student information is stored. The repository **104** can be implemented using other database technology, such as those based on the entity-relationship model, the hierarchical model, and the network model.

In the network environment of FIG. **1**, repository **104** is distributed over the computers that constitute the network. Certain redundant information is kept in the servers, so that in the event that part of the network is down, then the information which goes into the repository can be held in a server. Similarly, courses may be stored on multiple servers so that access to a given version of a course is possible without accessing the central repository **104**. Periodically, the distributed database is verified with respect to the information held in the central repository **104**, so as to assure that no inconsistent information is held by any of the servers. The verification process comprehends updating, at all sites in the network, the programs which are implementations of courses, and the databases which store enrollment information, charges for courses, and locations for course versions.

A student working on a workstation **124** requests a course. This prompts two actions from the server **106** attached to the LAN which the workstation is attached. The first action is to check whether the student is authorized for taking the

course. If the student has been authorized to enroll, the second action, searching for the course, commences. Searching for the course entails first looking in the local copy of the repository to see if the current version of the course is resident on the server. If it is not, the network is searched. In the preferred embodiment of the invention the server sends queries to the other servers **106** in the network **100**, asking for the course. If a queried server has the course, it replies to querying server with the location of the course. If the queried server does not have the course, it passes the query on to all other servers, unless it recognizes the query as being one which it has already passed on to other servers, in which case the queried server does nothing.

The search for a course eventually leads to the main computer **102**. All courses are stored in the repository **104**, therefore, the query can be satisfied. The appropriate reply is sent back to the requesting server.

Because the search may go through several paths in the network, it is possible that more than one server replies with the location of the course. For that reason, the number of links which the course must pass through, and the transaction cost associated with each link is computed as the reply makes its way back to the requesting computer. The requesting computer uses this information to decide from which server it can most expeditiously and inexpensively copy the course. It then requests that the course be copied to its file storage. At the same time, the information that the course is being copied to the requesting server is sent to the main computer **102** so that repository **104** can be updated.

FIG. **3** shows the programs operating on a server **106** and two workstations **124** according to the preferred embodiment computer aided instruction system. When a student requests a course it is not copied beyond the server **106** which serves the LAN to which the student is connected. The student's workstation merely receives an execution module **311** for the course. This execution module **311** interacts with a course control module **309** in the server. FIG. 3. shows this architecture. Student A, on workstation **124A**, executes execution module MSG_1.EXE (311A). The corresponding control module MSG_1.CTL (309A) executes on server **106**. These two modules communicate via the LAN that connects the workstation **124A** to the server **106**. Similarly, student B, on workstation **124B**, executes execution module MSG_2.EXE (311C), which in turn communicates with control module MSG_2.CTL (309C), on server **106**.

Thus, by giving the student access to the execution module **311** of a course does not give up control of the course. The course control module **309** is never down loaded beyond the server level. Thereby making it impossible for a student to make copies of a course and distribute it to colleagues. In the event a copy is made of the execution module **311** of a course and that module is executed on another workstation, it will try to access the corresponding control module **309** on a server, which in turn would be able to do the requisite course management.

Server **106B** also has connected to it file storage **114B** which contains the execution modules for the various courses resident on server **106B**. The purpose of storing the execution modules on the server is two fold: first, so that the execution module can be down loaded to the workstations connected to the server, and, second, so that if another server requests a course, both the execution module and the control module for that course can be copied to the requesting server.

FIG. **4** shows more detail of the programs resident on each server **106** and each workstation **124**. On the servers **106** a course request manager **403** responds to course requests made on workstation **124** by means of a course request program **405**. The workstation **124** is connected to a CRT **407**, a keyboard **411**, and a mouse **409**. A student operating workstation **124** interacts with the programs resident on workstation **124** using devices **407**, **409** and **411**. In the operating system controlling the workstation (e.g., DOS or UNIX) there are ways for invoking the course request program **405**. The course request program **405** may interact with the student using a menu oriented interface or by accepting commands typed on keyboard **411**. When the course request program **405** obtains a course request from a student it sends a message to server **106**, in particular to the course request manager **403**. The course request manager **403** then checks the local repository to determine if the student is authorized for the course and if the course is resident on the server **106**. If the authorization is not found on the server, then course request manager **403** sends a message to the main computer **102** via the network **100**. Similarly, if the course is not found on server **106**, course request manager **403** initiates a search, as described above.

The course execution modules **311**, are resident on workstations **124**, and consist of screen manager **413**, a course program **415**, a control module interface **417**, and an input/output interface **419**. The course program **415** is the kernel of the course execution module **311**. It contains, in computer executable form, the educational material taught through the course. The course program **415** interacts with screen **407** via screen manager **413**, and with printer **421**, keyboard **411** and mouse **409** via input/output interface **419**. Course program **415** interacts with course control module **309** through control module interface **417**. Control module interface **417** sends messages over the LAN to the execution module interface **401** of course control module **309**.

Each course control module **309** contains an execution module interface **401**. The role of the interface is to receive and send messages to the execution module **311** corresponding to the control module. Furthermore, each course control module **309** for a course contains an authorization check procedure, a billing procedure, a progress control procedure, a master instructor query procedure, an obsolescence check procedure, a reference materials procedure, and a bookmarking procedure. Each of these procedures may access the network by sending messages to other servers **106** and to the main computer **102**. These procedures also access the local version of the repository, thereby making it possible for the course management on the main computer **102** to access the databases on the various servers **106** to update student progress and course enrollment.

An additional advantage of splitting a course into a control module **309** and an execution module **311** is that certain portions of a course may be retained on the servers **106**, thereby freeing disk resources on the workstations **124** and facilitating course maintenance. For example, if a course is found to have a defective routine, and that routine is located on the servers **106** rather than on the workstations **124**, then it is possible to replace the routine without changing the portions of the course resident on workstations **124**. This is advantageous because typically there is no central control over the software resident on individual workstations **124**.

Course control module **309** contains a bookmarking facility. This is a procedure which is responsive to a message from a student that he or she wishes to take an extended pause from the course but return to it at the exact current state. In other words, the student's location in the course and the current results Are saved into a bookmark file. This file

is stored on the file storage device of the server. In an alternative embodiment the bookmark file is created on the workstation and saved on the workstation's file storage.

Returning to FIG. **2**, relation (also known as table) **201** contains the status of each course. As courses are updated older versions of the courses become obsolete. The status column is used to store information about which courses are current and which are obsolete. The date column serves a dual purpose, namely, for current courses it indicates when that version became the current version, and for obsolete versions, the date column indicates when the course will no longer be available. As can be inferred from FIG. **3**, an obsolete course may remain available after it has become obsolete, so as to allow students to complete the same version of a course as the version in which they started the course. However, after a predetermined obsolescence period the course is made unavailable, regardless of whether certain students have yet to complete it.

Relation **201** is also a store for information on where to find local versions of the courses. The "executable location" column gives a disk address where the executable module for a course is located and the "control location" column gives the corresponding location for the control module. The actual programs which make up a course are located on disk drives **211** and **213**.

Relation **203** is a store of the students' status information with respect to relevant courses. Examples of status are "authorized for enrollment", "completed", "dropped out", "falling behind", "progressing satisfactorily", and "pausing". Relation **205** is a store for students' grades. Relation **207** contains a list of "master instructors" for all courses. A master instructor is a person with particular skills relevant to particular courses. If a student on a workstation **122** has a problem with understanding a course the student can invoke a special query procedure which retrieves the master instructor's name and network address, and allows the student to send a message to the master instructor. This message contains the student's name and network address so that the master instructor can respond to the question.

For maintenance purposes and to facilitate locating courses, relation **209** contains a list of all servers where the various courses reside. Thus, if a course becomes obsolete, a message may be sent from the main computer to all servers which have that particular course resident, so that the servers may make the course unavailable on the obsolescence date.

Resident on main computer **102**, of FIG. **1**, is a supervisory program **128** responsible for maintenance of repository **104**. One task of supervisory program **128** is the automatic archiving of the database tables in repository **104**. Tables **201** through **209** continuously grow as new courses are added, old courses become obsolete, students enroll, and students finish courses, etc. When the tables become very large performance of the system degenerates. Therefore, information about obsolete courses is removed periodically, e.g., once a week or once a month. When information is removed from the tables, it is moved into one or more archival files **215**. Supervisory program **128** also contains code to recover information from archival files **215**. A similar maintenance task is done on the various servers **106** by programs **130A–130C**, respectively, i.e., moving information about obsolete courses from the database tables resident on the server into archival files, also resident on the server. These archival tasks are automatically triggered to occur at specific times or by specific events, e.g., a certain number of course versions have become obsolete or the number of students who have completed courses reaches a specified number.

Supervisory module **128** also provides on-line maintenance of the programs and databases supporting enrollments, charges for courses, and locations of course versions across the network.

The network **100** in FIG. **1** also contains provisions for uploading courses from workstations located anywhere in the network to the central repository **104**. A course author may be located on any workstation and send a message to main computer **102** that a new version or a new course has been completed. The main computer **102** would then initiate moving the executable module and the control module for that course into disk drives **211** and **213** and update relations **201**, **207**, and **209**, as appropriate and as approved by the curriculum advisory authority.

The courseware according to the present invention incorporates several features which improve student interest. For example, interaction with the courses and course management software is menu driven and icon based. The courses are implemented so that a student can request animation and simulation of the material covered in the course, as provided by the course author. Furthermore, the courseware incorporates interfaces to video material. In other words, a student taking a course on the assembly of a computer can request that certain steps be shown through video and that other steps be simulated using on-screen graphics and animation. In an alternative embodiment, these features are automatically executed when the student takes the course.

Returning to FIG. **4**, the courseware according to the present invention includes a diagnostic expert system **421** which runs in the background of the course. The diagnostic expert system **421** is privy to all transactions between the student and the course. Using built in rules it directs the student through the course. If the student has particular difficulty with one subject area, the diagnostic expert system **421** increases the level of detail of the instruction in that subject area. On the other hand, if the student excels, the diagnostic expert system allows the student to progress through the course at a higher pace. The diagnostic expert system **421** analyzes the student's responses to questions to determine for which areas the student requires training. The diagnostic expert system **421** is a series of hook-points to particular addresses in the machine code implementation of the course. Using rules based on particular student responses, or on incorrect responses, the diagnostic expert system **421** directs the student to the appropriate training screens.

Also resident on servers **124** is an authoring system. The authoring system **124** provides an intelligent environment in which a course author creates courses. In the artificial intelligence domain of expert systems, a human expert is interviewed by a knowledge engineer, who builds an expert system. In the authoring system, templates for course screens are automatically derived from the expert interview.

Furthermore, the authoring system **124** incorporates an editing facility which allows for global search and replace of text strings, graphic images, etc. for entire course.

The authoring system **124** also provides a mechanism to allow authors to put string variable operations into courses. For example, in a VMS operating system course, a possible question is "Type an example of a directory command which lists all Pascal files created today." Several correct replies are possible, e.g., "$ DIR/SINCE *.PAS", "$ DIRECTORY *.PAS/SINCE", and "$ DIR/SINCE=TODAY [ ]*.PAS". Any of these replies should be considered a correct response. Similarly, the authoring system provides a mathematical function interface, wherein a student replies to questions

using mathematical functions rather than by giving exact numbers. An example from electrical circuit theory is a problem to calculate the current through a particular resistor in a circuit. The answer to that question can be described in terms of Ohm's and Kirchhoff's laws rather than by giving the exact numerical value.

Related to the networked computer aided instruction system of the preferred embodiment is embedded training. In this aspect of the preferred embodiment the training is incorporated into the various computer programs executing on a workstation. This is illustrated in FIG. **5**. Application program **501** is a screen oriented program. It is composed of eight interaction screens **505A–505H**. Each interaction has a "hook point" to which is linked an embedded training screen **507A–507H**. Through some action of the user of the application program, e.g., pressing a help button, the embedded training screen is invoked. The embedded training would be particularly pertinent to the screen from which it was invoked. Typically, the student is allowed 30 seconds to three minutes for completing the embedded training for a particular topic. However, if the student does not learn sufficient detail from the embedded training, then he or she may transfer directly from the embedded training to the computer aided instruction course **311** associated with the application program.

FIG. **6** shows two key features of the preferred embodiment. First, in the preferred embodiment courses are implemented for multiple levels of detail. In a university environment there is a distinct level of detail required by the University President who merely wants to know what the various offered courses teach, and the student who is trying to master a subject. Accordingly, in the preferred embodiment courses are developed for five different levels: Acquaintance, Familiarity, Competency, Proficiency, and Master Proficient. When a student invokes a course, the course queries the student as to what level he or she wishes to enroll.

The "Acquaintance" level is a high level overview of the subject matter of the course with no detail attached, e.g., looking at the objectives covering each lesson. The "Familiarity" level gives the student the ability to page through a course while reviewing detail information without having to respond to questions. The student also has the ability to branch to chapters or sections within a chapter. In the "Competency" level a student is presented material that will be test at the end of each lesson. The student must attain a specified passing score, e.g., seventy, in order to be certified as competent on the subject matter. The passing score indicates that the student is qualified to perform the tasks reviewed in the subject matter presented.

In the "Proficiency" level the student is first pretested to record the student's level of proficiency prior to taking the course. The student must pass any prerequisite course or topics required before enrolling into the course. Upon satisfying the prerequisite test the student is presented materials in which question and answer dialogues are continued throughout the course delivered to the student. The student must respond to multiple questions within the text delivered as well as pass a thorough test at the end of each lesson. Finally, the "Master Proficiency" level requires not only a prerequisite test as a requirement for enrollment but upon completion of the course, the student must be able to critique material given and append their knowledge to the topics covered by the course. After all tests are completed the student must maintain a high score, e.g., at least 90, for the entire course in order to be judged master proficient.

Furthermore, the courses are developed so as to give the student multiple options in terms of testing competency. First, the courses implement walk-throughs, in which students are guided through the procedure being taught by the course. A second technique is "Follow me" in which the course simulates the task that the student wishes to learn. Courses also implement exercises. These serve the dual purpose of giving the student some knowledge about his or her own progress and of giving the course administrators a means of monitoring student progress. In some courses the student may be required to complete a certain number of exercises in a given time unit, e.g., one set per week. If the student fails to meet this requirement, the course sends a message to the main computer to change the student's status to "falling behind." This status gives course administration notice to let the student's management know that the student is falling behind or having some kind of problem with the course.

FIG. **7** shows more detail of the embedded training system according to the preferred embodiment. The workstation is controlled by operating environment **703**. This environment controls application programs **701A–701G**, the embedded training software **705**, and the education resources **707**. As discussed above, each application program has one or more hook points into the embedded training software. More than one application can share the same embedded training. For example, in standardized user interfaces, many applications will do file access in the same manner, therefore it is appropriate that the training software associated with file access is common for all applications which share the file management software. The embedded software accesses the education resources **707**. The education resources is a centralized repository for such things as the student workbook **709**, the glossary **711**, the tutorials **713**, simulation software **715**, error correction software **717**, and the Index of Computer Based Training (CBT) courses **719**.

In the embedded training aspect of the present invention, the diagnostic expert system **421** serves the role of monitoring the interaction of a system user with a system, and analyzing that interaction to determine when the user needs training in a particular subject matter. For example, if the embedded training is used in conjunction with an operating system and a user is trying to copy files, but fails to do so because of incorrect file specifications, the diagnostic expert system **421** executes a training screen on how to formulate a correct file specification.

FIG. **8** shows an example of a knowledge base of rules for the diagnostic expert system. Column **801** contains specific rules and column **803** the logical location where the course should resume if the rule is true. The entries in column **803** are in terms of the goals for the transition. For example, in row **809** if a student or user has problems with file specifications, the training screen for file specifications is displayed. Column **805** contains the memory locations for the machine code implementing the training screens in column **803**.

FIG. **9**(*a*) shows the flow of control through the pre-enrollment phase of a course according to the present invention. The student may be required to take a prerequisite test, step **1001**. This is a computerized or computer randomized test. The results from the test is analyzed in step **1003** to determine to which course level the student should enroll. If the student failed the test, he or she is directed to take a remedial course, step **1005**. Step **1007** entails building a menu of the options available to the student in the event he or she attained a passing grade on the prerequisite test. The menu **1017**, shown in screen **1015** of FIG. **9**(*b*), is displayed to the user. The student has the options of taking all levels of the course, start at the level his or her score indicates to

be the appropriate level given the student's competence level, and to bypass the course all together. These choices are shown in menu **1017** of FIG. **9**(*b*).

After selection of a level, the course **1009** is invoked, during which the student reads materials, views video material, and answers questions. During the execution of course **1009** a summary file **1021** is built. The summary file **1021** is used in step **1011** to analyze the questions with respect to the answers given by the student. This analysis entails highlighting questions which are repeatedly answered incorrectly, so that the course or the question can be revised. The summary files and the analysis done on every server are sent via network **100** to the course author or course manager. The course author or manager further analyzes the summary files from multiple servers to decide whether the course should be revised, and revises the course, step **1013**. In the event the author or manager revises the course, he or she sends the new course version to the main computer **102**, where the courseware administrator decides whether or not to include the new version into the main repository. If the course is included, the version it replaces may be made obsolete, in which case a message to that effect is sent to all servers where the course resides and to all students currently enrolled in the course.

FIG. **10**(*a*) shows the main menu of the course authoring system. The author interacts with the main menu by selecting the number of the desired option. As indicated the author may create a new course, edit a course, or delete a course. The main menu also provides an option for exiting. The selections which the author makes causes the authoring system to display one of several alternative screens.

FIG. **10**(*b*) shows the screen which the authoring system displays whenever the author selects the "Edit course" option. For example, the author may use the EDIT COURSE MENU, shown in FIG. **10**(*b*), to add a new frame, edit an existing frame, change frame parameters, select an interactive video/speech frame, delete a frame, print frames, copy frames, or run the training package. A frame is a unit of course-to-student interaction. Although not required, a frame often corresponds to one screen of information. However, because there is no limitation on frame size, two or more frames may be displayed on the screen at one time. This feature is useful to display a graphic in one frame, and querying the student about the graphic through another frame.

The "add a new frame," option transfers the user into the menu shown in FIG. **10**(*c*), which is discussed in further detail below. The "edit a frame" option gives the author the ability to edit an existing frame. Frames can exist of text and graphics. Therefore, both the "add a new frame" and the "edit a frame" options enable the author to create and edit both text and graphics. For example, the authoring system, allows the user to create lines, circles, boxes, arcs, slices, and curves, in a frame. Similarly, in terms of text manipulation, the authoring system enables the user to select from different fonts. The frame editor also provides tools for image reproduction, and image manipulations, such as moving, deleteing, scaling and rotating images or portions of images. Further image manipulations include screen capture and the use of a full color palette for frame creation and editing.

The "modifying physical frame parameters" option refers to manipulation of frame size. Frames can make reference to interactive video and speech materials. The author uses the tools provided through the "interactive video/speech" option to establish the links of frames to these materials.

The main menu also allows the author to remove frames from courses, copy frames from one course to another, and to run the training package.

FIG. **10**(*c*) shows some of the types of frames available to a course author. These are meant to be illustrative rather than limiting. The title frame **901** is used to display the course title and listing the course objectives. Other possible entries on the title frame are company logos and names of course authors, as well as last version of course.

The introductory frames **903** are used to communicate, to the student, the mechanics of the course, e.g., how to execute the package, how to answer various types of questions which appear in the course, who to contact if any difficulties arise, and how to exit the course should the student desire to leave. Title frame **901** and the introductory frames **903** are both text frames, i.e., they are non-interactive.

Frames **905** through **913** are interactive question frames. These are both used to allow the student to navigate through the course and to ask the student questions about the subject matter of the course. The latter category, subject matter questions, as discussed above, are created by an expert system. The course author is not necessarily the subject matter expert. The course author interviews the subject matter expert and creates an expert interview file. The expert system accepts as its input the expert interview file and automatically creates templates for course frames. The author edits these frames using the frame editing facilities of the authoring system.

The authoring system allows the author to define a last frame **915** specification. The last frame **915** is a summary frame and provides the student with information such as which is next course in a sequence of courses, who to contact to obtain a course completion certificate, and a sign-off message. The last frame is also used to verify that the person who completed the course is the same person who started taking the course.

FIG. **11** shows three views of a course. In the first column is the authoring system interactions used to create the course, in the second column is the structure of the course, and in the third column is the student's view of the course. By being able to view multiple windows, the course author has access to both the authoring system interaction view and the studentes view.

While FIG. **11** shows some example frames that may be used in a course, a course is not limited to this structure, and a person skilled in the art will realize many possible alternative course structures.

The authoring system displays screen **150** by selecting the "Title Frame" option in the menu shown in FIG. **10**(*c*). The author enters the course title and course objectives in the indicated fields of screen **150**. The authoring system takes this information and creates the structure **152** for the corresponding title frame. When the student executes the course, the title frame is displayed as shown in screen **154**.

The author creates the introductory frames by first selecting the "Introductory Frames" option on the menu shown in FIG. **10**(*c*). The introductory frames may either be entered interactively or incorporated from computer files, as shown in screen **156**. The introductory frames may also be derived from the expert interview. When the author has completed creating the introductory frames they are incorporated into the course structure in blocks **158**. The student views the introductory frames as shown in screen **160**. The introductory frames provide means of navigation forward and backwards through the frames, as indicated by buttons **162A** and **162B**. The forward and backward navigation can also be accomplished by using cursor keys or specially designated function keys.

Certain types of frames create multiple paths through the course. This is illustrated by YES/NO question frames **164** through **172**. The author is prompted by the authoring system for text of a question, e.g., "Do you wish to continue the lesson?". This creates the required structure in the course, such as the frame **166** and the logic block **172**. The course displays the screen **168** to the student. Logic block **172** provides two paths: one for the "yes" answer and one for the "no" answer.

In the course shown in FIG. **11** the "no" response results in the display of a text frame **178**. The author is prompted for the text or a filename of a file where the text can be found, as shown in block **174**.

Another multiple path frame is the menu frame **182** shown in FIG. **11**(*b*). It is created using screen **180** of the authoring system. In screen **180** the author is prompted for the number of choices in the menu and the titles of the various choices. The authoring system uses this information to create the structure shown below block **182**. The menu created by the authoring system is displayed to the user as shown in screen **184**. Screen **184** also displays to the user the topics that he or she has completed as indicated by the √ symbol displayed next to the course title. The author is also prompted for frame identifiers for the frames that represent the paths corresponding to the various choices (This is not shown). Each path corresponding to a menu choice consists of a sequence of frames **186A–186F**, respectively. The paths exiting a sequence of frames **186** may take one of several routes, e.g., back to menu frame **182** for further selections, as shown from frames **186A–186E**, or to other parts of the course, as shown exiting from frame **186F**.

Screen **188** shows an example of the interaction between the authoring system and the course author for the creation of a text frame which make up one of the sequences selected through menu frame **182**, in this case a multiple choice frame. The frame may have originated as a template created by the expert system from the expert interview and subsequently edited by the author. An example of the flow of control from a multiple choice frame is shown in FIG. **11**(*d*) as blocks **264** through **272**, and is discussed in further detail below.

Another possible interaction frame is the "true/false" question frame, shown in FIG. **11**(*c*) as blocks **250–262**. The authoring system requires the author to create a question, indicate whether "False" or "True" is the correct response, and provide feedback information for both alternatives. From this information the authoring system creates the structure shown as frame **252**, logic block **256** and feedback frames **258** and **260**. The student views the question as shown in screen **254**, which also includes response buttons **255A** and **255B**. When the student buttons a response, e.g., the F button **255B**, control in the course goes through the path corresponding to that button, which in the shown example is through feedback frame **260**. Feedback frame **260** is displayed as shown in screen **262**.

FIG. **11**(*d*) shows the course structure corresponding to some additional interaction screens. (Not shown is the authoring system interaction and the student interaction. These are similar in nature to those of the frames discussed above.) Multiple choice question frame **264** can have two or more possible answers. Usually one answer represents a correct response. A text frame **266–272** is associated with each response to give the student feedback regarding the entered response. For incorrect responses the course may return to the question frame **264**, as shown, or, alternatively, not give the student the opportunity to attempt to answer the question again.

Blocks **274–280** represent a question asked through a fill-in-the-blank frame. Text frame **274** introduces the question and gives the student any additional information needed to answer the question. Question frame **276** presents the question to the student with blanks to fill in. Block **277** is a pattern matcher, which functions to determine whether the answer provided by the student matches the pattern given by the author. As with the multiple choice question and the true/false question, discussed above, the course provides feedback to the student depending on the student's response to the question, as shown by blocks **278** and **280**.

The example course shown in FIG. **11**, concludes with frame **290** which provides the course wrap-up information discussed above in conjunction with FIG. **10**(*c*).

While this invention has been described with reference to illustrative embodiments, this description is not intended to be construed in a limiting sense. Various modifications and combinations of the illustrative embodiments, as well as other embodiments of the invention, will be apparent to persons skilled in the art upon reference to the description. It is therefore intended that the appended claims encompass any such modifications or embodiments.

We claim:

1. A network system for computer aided instruction, comprising:

a main computer including a repository for storing courseware;

a network of servers connected to said main computer, each of said servers having a control module;

a plurality of local area networks, each of said local area networks connected to a server, and each of said local area networks comprising a plurality of interconnected workstations;

a distributed delivery system responsive to a request of said server for a course of said courseware, selectively operable to search said network of said servers for said server where said course resides, operable to transfer said course from said server where said course resides, and selectively operable to retrieve said course from said repository if said course cannot be found at said server;

an authoring system distributed over a workstation of said workstations, said servers and said main computer, and operable to transfer courses of said courseware from said workstation to said repository; and

a course management system distributed over said workstation, said servers and said main computer, and operable to manage course enrollment and to monitor student performance at said servers, and further operable to transfer information corresponding to said course enrollment from said servers to said main computer;

wherein said network of servers comprises a first set including said servers connected to said main computer, a second set including said servers connected to other servers and to said main computer, and a third set including said servers connected to said other servers; and

wherein said course is prevented from being copied by said control module.

2. The network system of claim **1**, wherein said repository comprises:

a database for storing additional information corresponding to said courses and students enrolled in said courses; and

file storage for the storage of programs implementing said courses.

3. The network system of claim 1, wherein said distributed delivery system comprises programs distributed over said servers in said workstation; and

wherein said programs communicate by sending messages.

4. The network system of claim 1, wherein said main computer further includes a supervisory module.

5. The network system of claim 4, wherein said supervisory module is operable to automatically archive information, to manage student enrollment, and course accounting.

6. The network system of claim 5, wherein said supervisory module is operable to request said other servers in said network to provide said supervisory module with information required by said supervisory module to maintain said repository.

7. The network system of claim 6, wherein said supervisory module communicates with said other servers by sending messages across said network.

8. The network system of claim 7, wherein said messages are standardized so that said servers of different manufactures can communicate with said other servers.

9. A computer aided instruction system, comprising:

a network of interconnected servers;

a main computer connected to at least one of said servers;

a repository connected to said main computer;

at least one workstation connected to one of said servers; and

an authoring system distributed over said at least one workstation, said servers, and said main computer to deliver a course from said at least one workstation to said repository; and

a diagnostic expert system to increase or decrease the level of detail of said course.

10. The computer aided instruction system of claim 9, wherein said authoring system comprises programs resident on said at least one workstation, said servers, and said main computer.

11. The computer aided instruction system of claim 10, wherein said programs communicate by sending messages.

* * * * *

US005960403A

United States Patent [19]

Brown

[11] Patent Number: 5,960,403

[45] Date of Patent: Sep. 28, 1999

[54] **HEALTH MANAGEMENT PROCESS CONTROL SYSTEM**

[75] Inventor: **Stephen J. Brown**, San Mateo, Calif.

[73] Assignee: **Health Hero Network**, Mountain View, Calif.

[21] Appl. No.: **09/136,512**

[22] Filed: **Aug. 19, 1998**

Related U.S. Application Data

[63] Continuation-in-part of application No. 08/481,925, Jun. 7, 1995, abandoned, which is a continuation-in-part of application No. 07/977,323, Nov. 17, 1992, Pat. No. 5,307,263, and a continuation-in-part of application No. 08/666,242, Jun. 20, 1996, abandoned.

[51] **Int. Cl.**[6] **G06F 17/40**

[52] **U.S. Cl.** **705/2**; 345/336; 395/200.38

[58] **Field of Search** 705/2, 3; 345/326, 345/336, 337, 338; 395/200.38, 200.39, 200.41; 600/300

[56] **References Cited**

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4,731,726	3/1988	Allen, III	364/416
4,803,625	2/1989	Fu et al.	600/483
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5,501,231	3/1996	Kaish	128/725

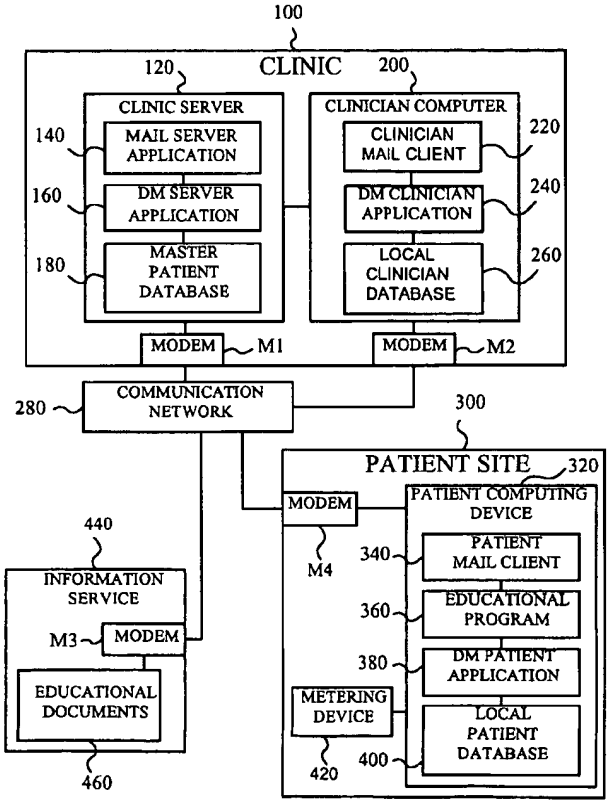
Primary Examiner—Stephen R. Tkacs

Attorney, Agent, or Firm—Lumen Intellectual Property Services

[57] **ABSTRACT**

A system and method for remotely monitoring a patient and for training the patient to comply with a treatment plan for a health condition. A patient computing device collects data relating to the patient's health condition and transmits the data to a clinician computer via a communication network. The data is analyzed in the clinician computer to determine an educational need of the patient for treating the health condition. An educational program corresponding to the patient's educational need is selected and a pointer to the educational program is embedded in an electronic message to the patient. The educational program is started on the patient computing device by selecting the embedded pointer in the electronic message. As the patient works with the educational program, new data relating to the patient's health condition is collected in the patient computing device and transmitted to the clinician computer for analysis. With this continuous feedback loop between the patient and clinician, the clinician is able to monitor the patient's progress and effectively train the patient to comply with the treatment plan.

29 Claims, 15 Drawing Sheets



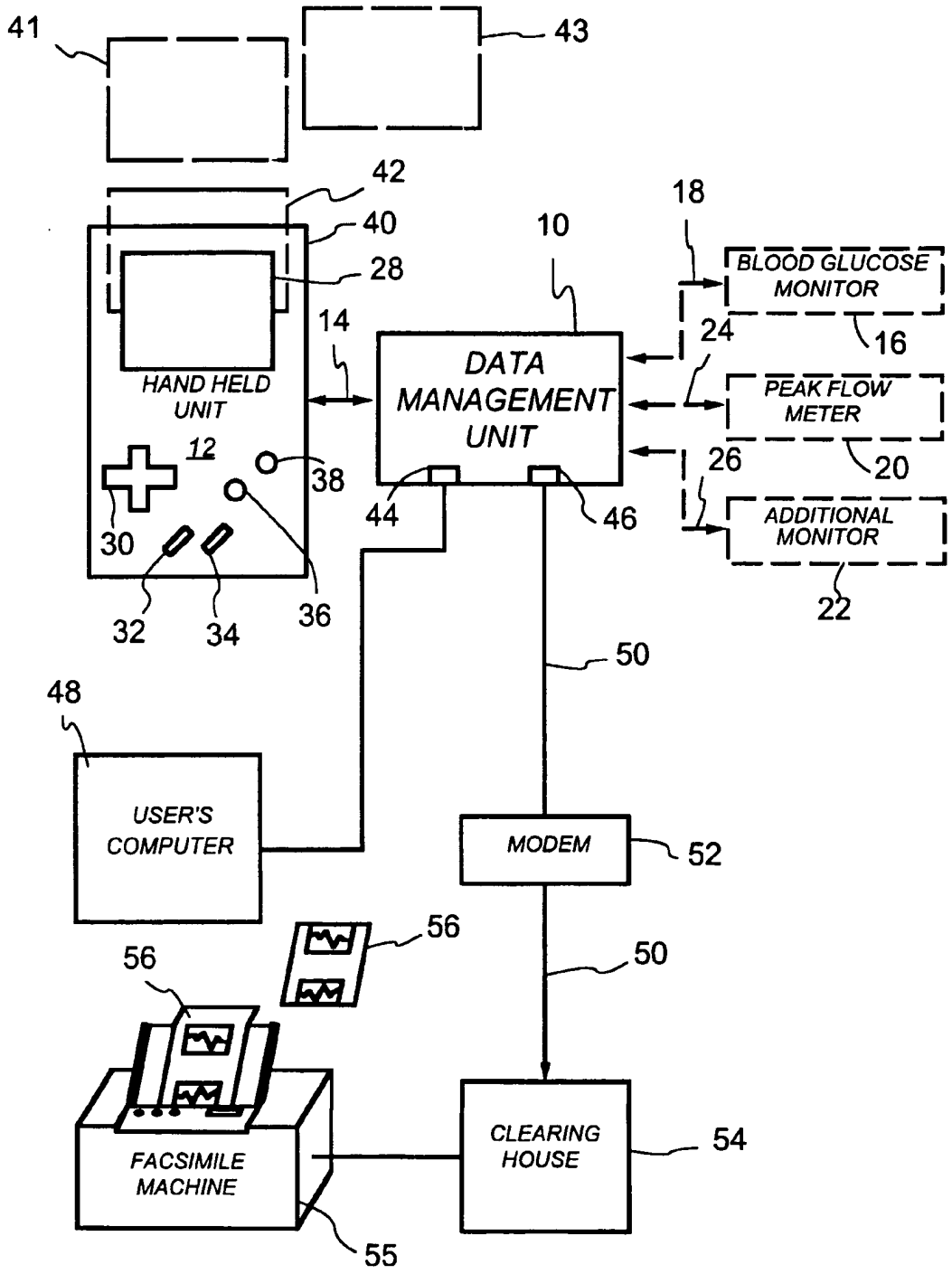

41
43
42
40
28
10
18
BLOOD GLUCOSE MONITOR
16
14
24
HAND HELD UNIT
DATA MANAGEMENT UNIT
PEAK FLOW METER
12
38
26
20
44
46
30
ADDITIONAL MONITOR
32
34
36
22
50
48
USER'S COMPUTER
MODEM
52
56
56
50
FACSIMILE MACHINE
CLEARING HOUSE
54
55

FIG. 1A

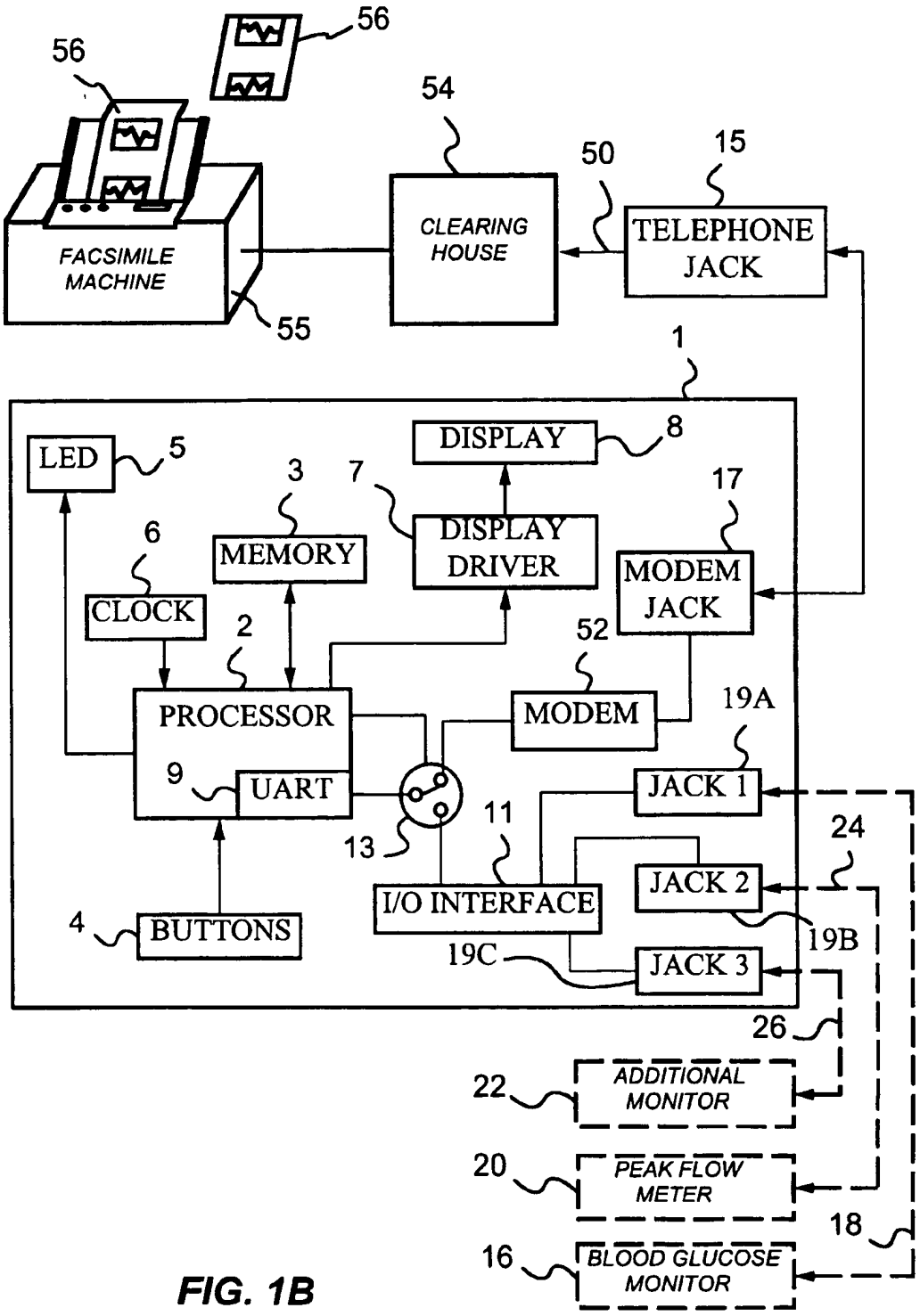

56
56
54
50
15
CLEARING HOUSE
TELEPHONE JACK
FACSIMILE MACHINE
55
1
LED
5
DISPLAY
8
3
7
17
6
MEMORY
DISPLAY DRIVER
MODEM JACK
CLOCK
2
52
PROCESSOR
MODEM
19A
9
UART
JACK 1
11
24
13
JACK 2
I/O INTERFACE
4
BUTTONS
19B
19C
JACK 3
26
22
ADDITIONAL MONITOR
20
PEAK FLOW METER
18
16
BLOOD GLUCOSE MONITOR

FIG. 1B

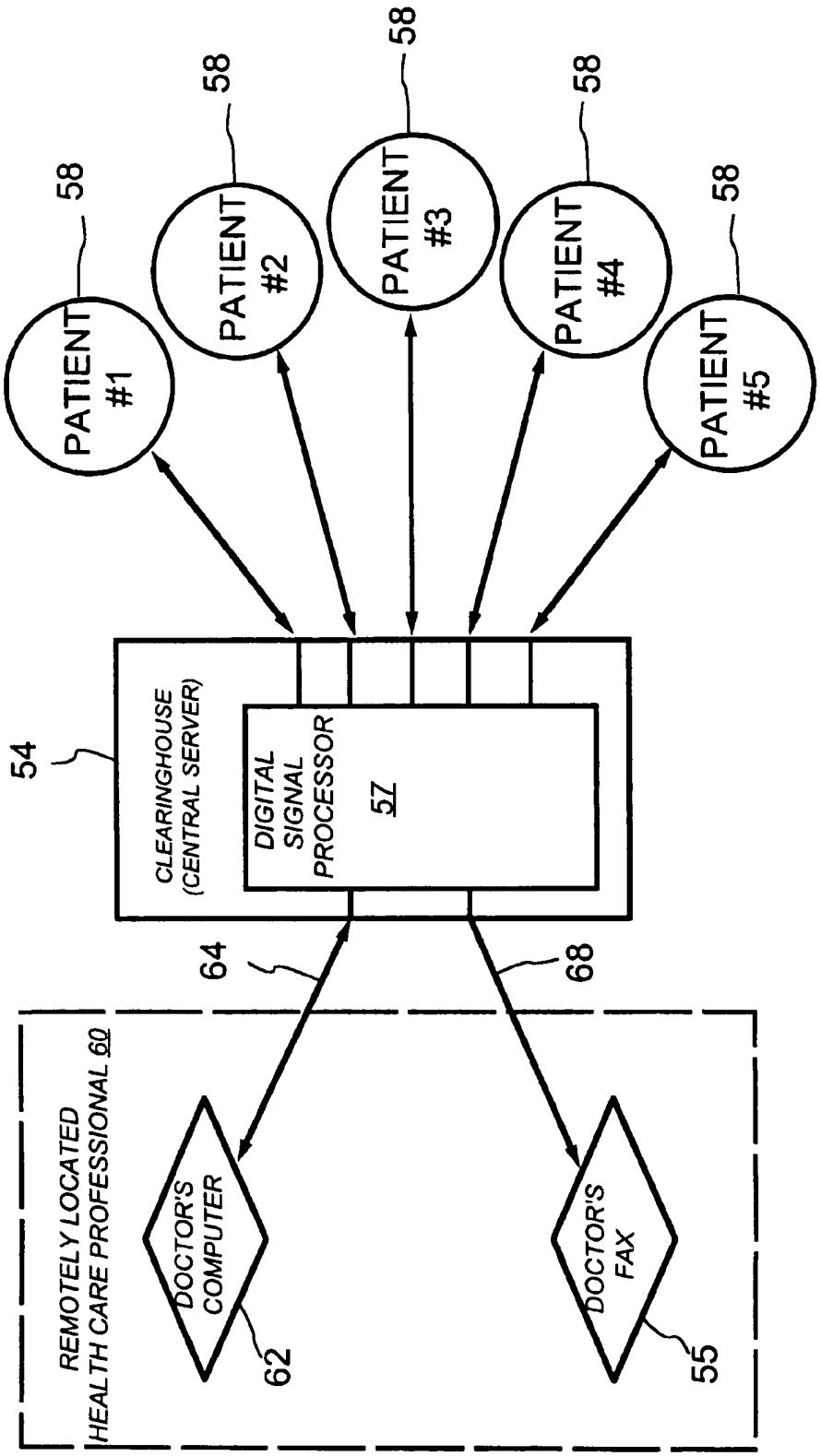

58
58
58
58
58
PATIENT #1
PATIENT #2
PATIENT #3
PATIENT #4
PATIENT #5
54
CLEARINGHOUSE (CENTRAL SERVER)
DIGITAL SIGNAL PROCESSOR
57
64
68
REMOTELY LOCATED HEALTH CARE PROFESSIONAL 60
DOCTOR'S COMPUTER
62
DOCTOR'S FAX
55

FIG. 2

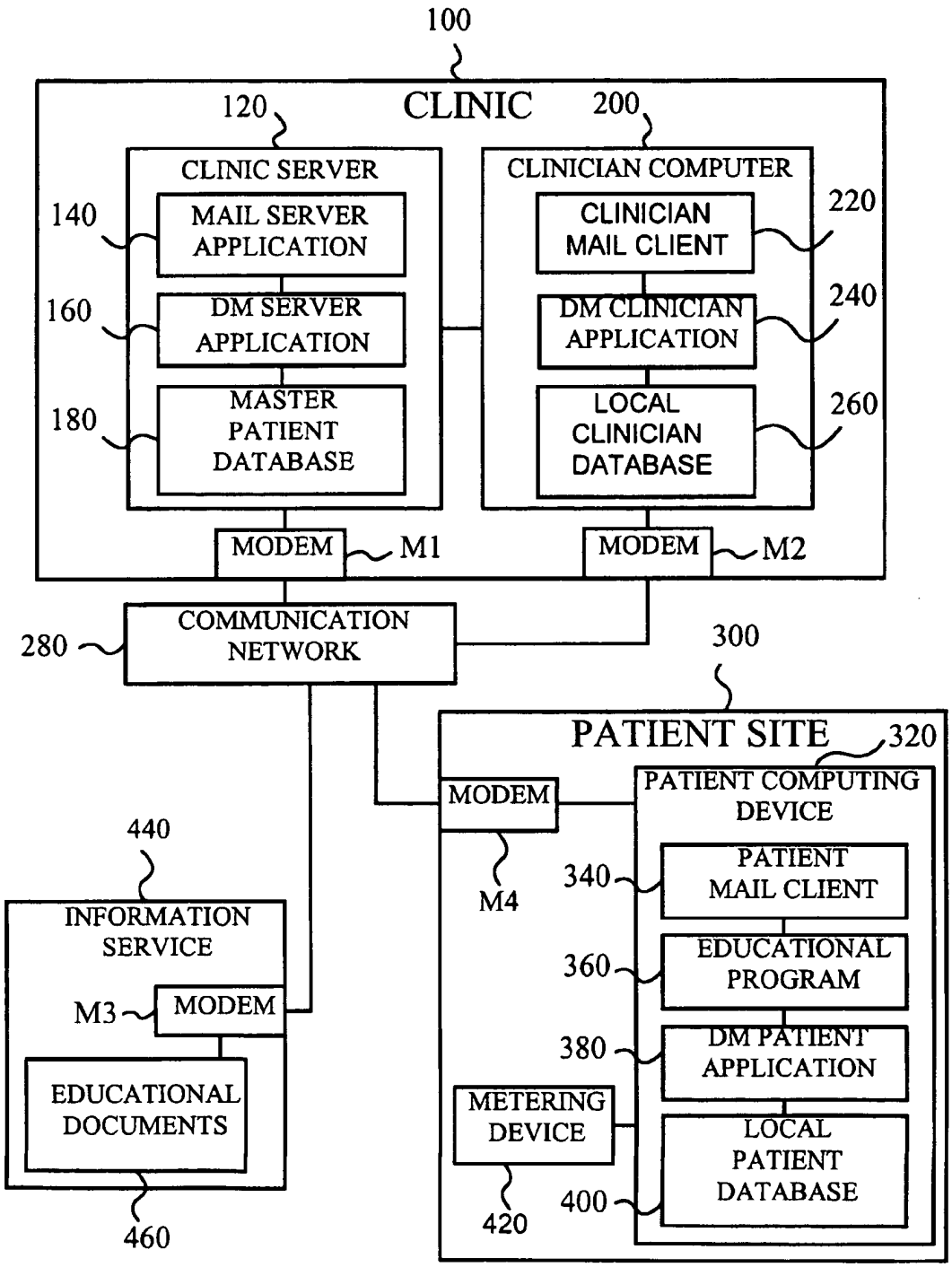

100
CLINIC
120
CLINIC SERVER
140
MAIL SERVER APPLICATION
160
DM SERVER APPLICATION
180
MASTER PATIENT DATABASE
200
CLINICIAN COMPUTER
220
CLINICIAN MAIL CLIENT
240
DM CLINICIAN APPLICATION
260
LOCAL CLINICIAN DATABASE
MODEM
M1
MODEM
M2
280
COMMUNICATION NETWORK
300
PATIENT SITE
320
PATIENT COMPUTING DEVICE
MODEM
M4
340
PATIENT MAIL CLIENT
360
EDUCATIONAL PROGRAM
380
DM PATIENT APPLICATION
METERING DEVICE
420
400
LOCAL PATIENT DATABASE
440
INFORMATION SERVICE
M3
MODEM
EDUCATIONAL DOCUMENTS
460

FIG. 3

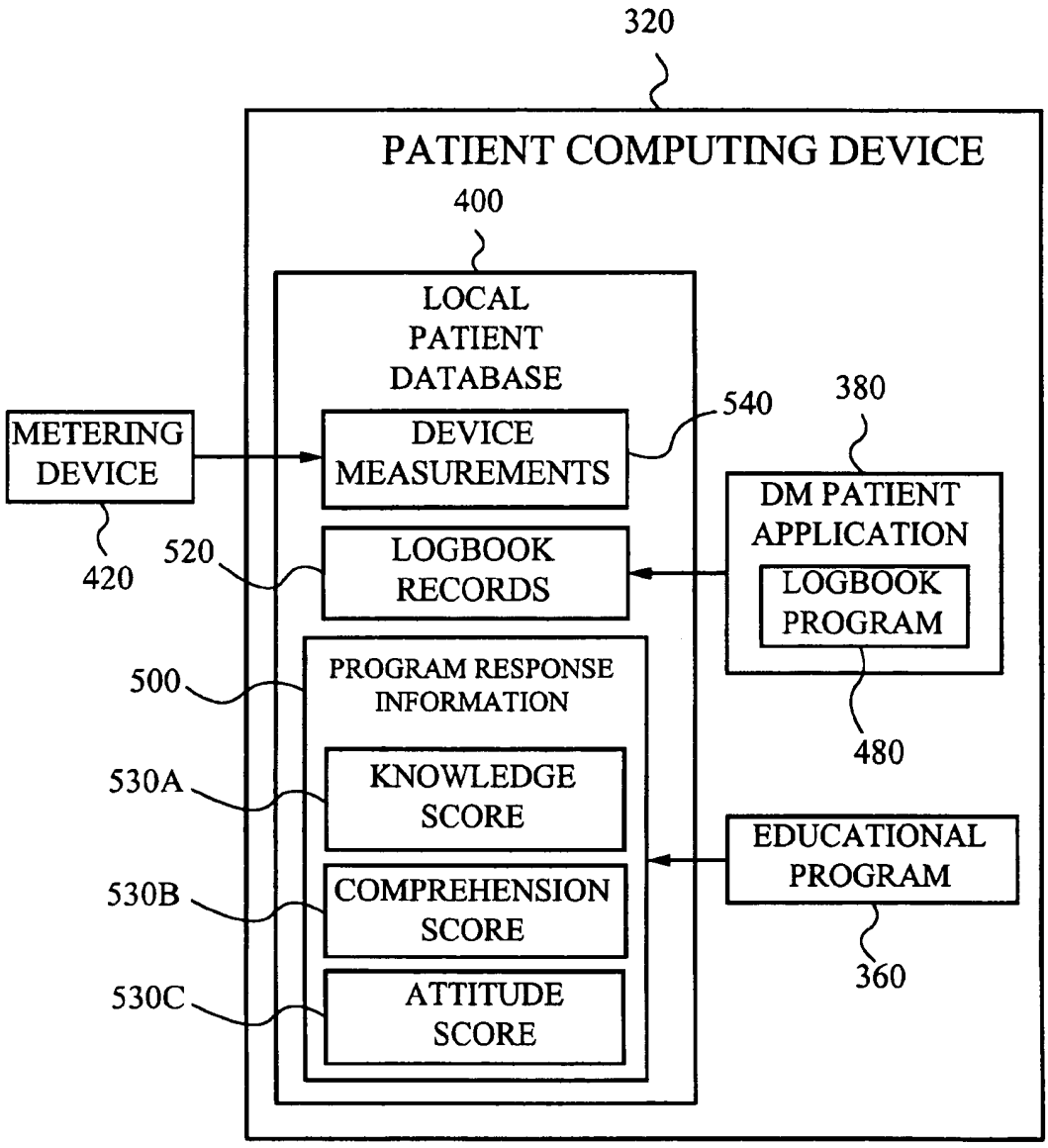

320
PATIENT COMPUTING DEVICE
400
LOCAL PATIENT DATABASE
METERING DEVICE
420
DEVICE MEASUREMENTS
540
380
DM PATIENT APPLICATION
LOGBOOK PROGRAM
520
LOGBOOK RECORDS
500
PROGRAM RESPONSE INFORMATION
480
530A
KNOWLEDGE SCORE
EDUCATIONAL PROGRAM
530B
COMPREHENSION SCORE
360
530C
ATTITUDE SCORE

FIG. 4

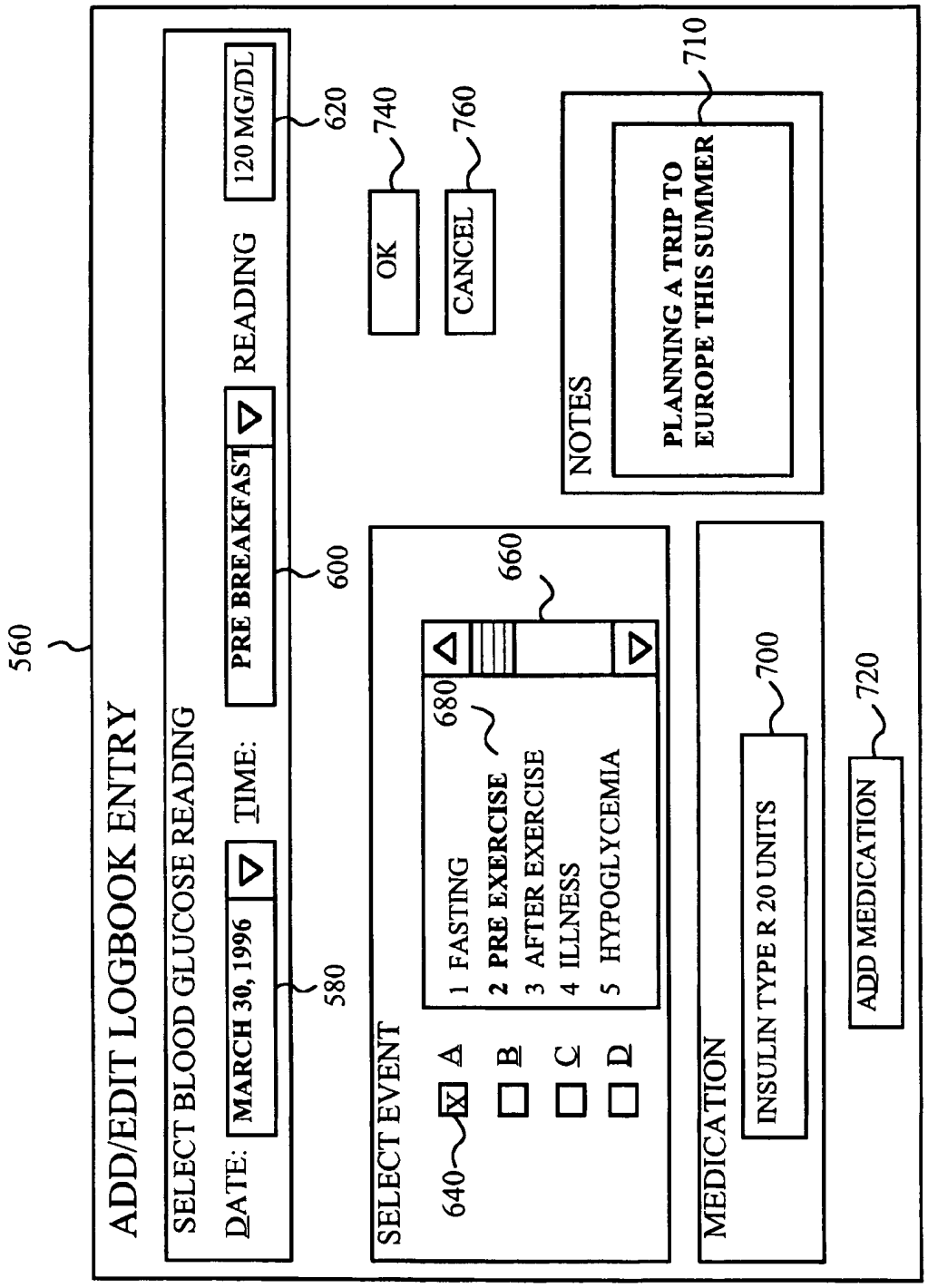

560
ADD/EDIT LOGBOOK ENTRY
SELECT BLOOD GLUCOSE READING
DATE:
MARCH 30, 1996
TIME:
PRE BREAKFAST
READING
120 MG/DL
620
740
OK
760
CANCEL
NOTES
PLANNING A TRIP TO EUROPE THIS SUMMER
710
600
660
SELECT EVENT
640
A
B
C
D
680
1 FASTING
2 PRE EXERCISE
3 AFTER EXERCISE
4 ILLNESS
5 HYPOGLYCEMIA
580
MEDICATION
INSULIN TYPE R 20 UNITS
700
ADD MEDICATION
720

FIG. 5

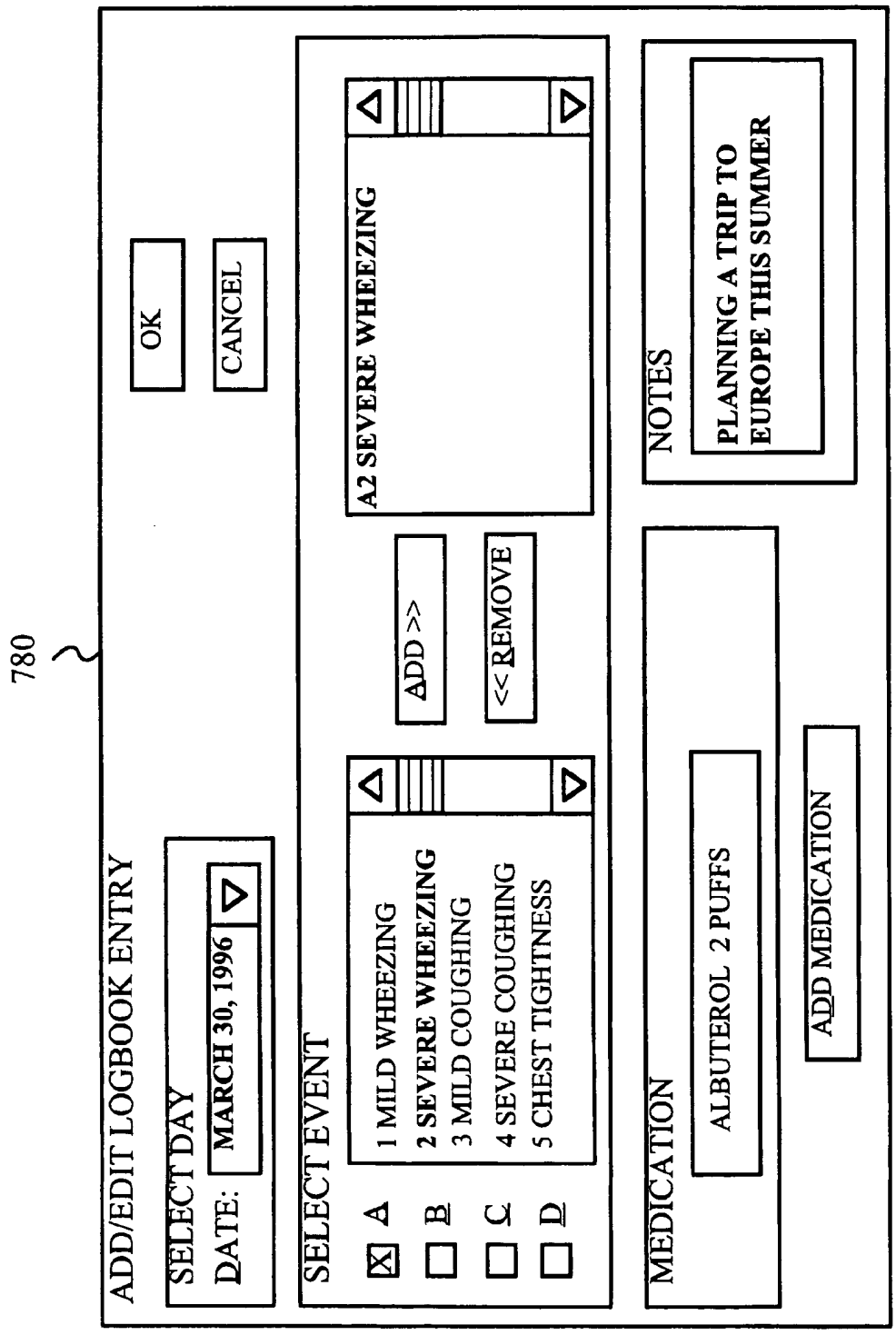

780
ADD/EDIT LOGBOOK ENTRY
SELECT DAY
DATE: MARCH 30, 1996
OK
CANCEL
SELECT EVENT
A
B
C
D
1 MILD WHEEZING
2 SEVERE WHEEZING
3 MILD COUGHING
4 SEVERE COUGHING
5 CHEST TIGHTNESS
ADD >>
<< REMOVE
A2 SEVERE WHEEZING
NOTES
PLANNING A TRIP TO EUROPE THIS SUMMER
MEDICATION
ALBUTEROL 2 PUFFS
ADD MEDICATION

FIG. 6

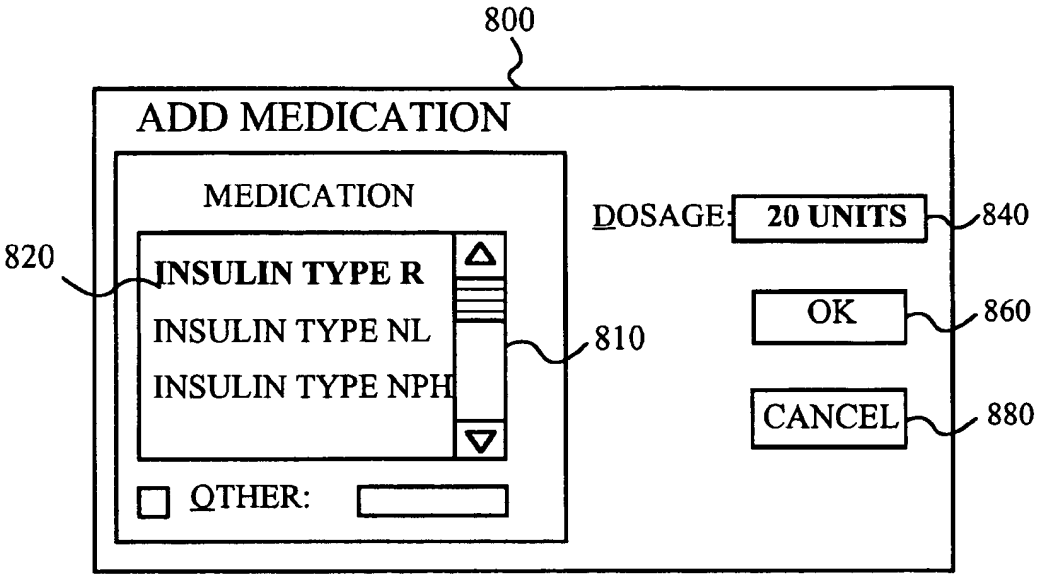

800
ADD MEDICATION
MEDICATION
820
INSULIN TYPE R
INSULIN TYPE NL
INSULIN TYPE NPH
810
QTHER:
DOSAGE:
20 UNITS
840
OK
860
CANCEL
880

FIG. 7

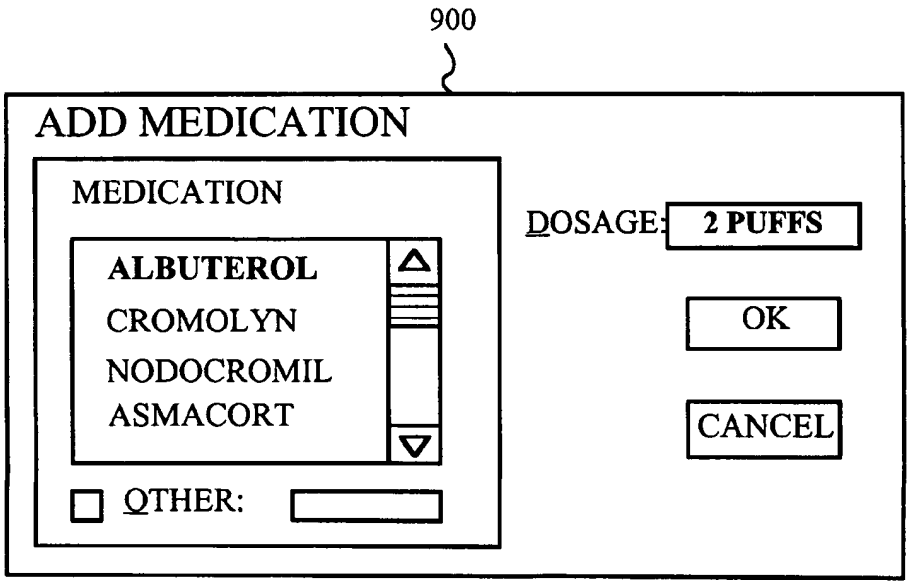

900
ADD MEDICATION
MEDICATION
ALBUTEROL
CROMOLYN
NODOCROMIL
ASMACORT
QTHER:
DOSAGE:
2 PUFFS
OK
CANCEL

FIG. 8

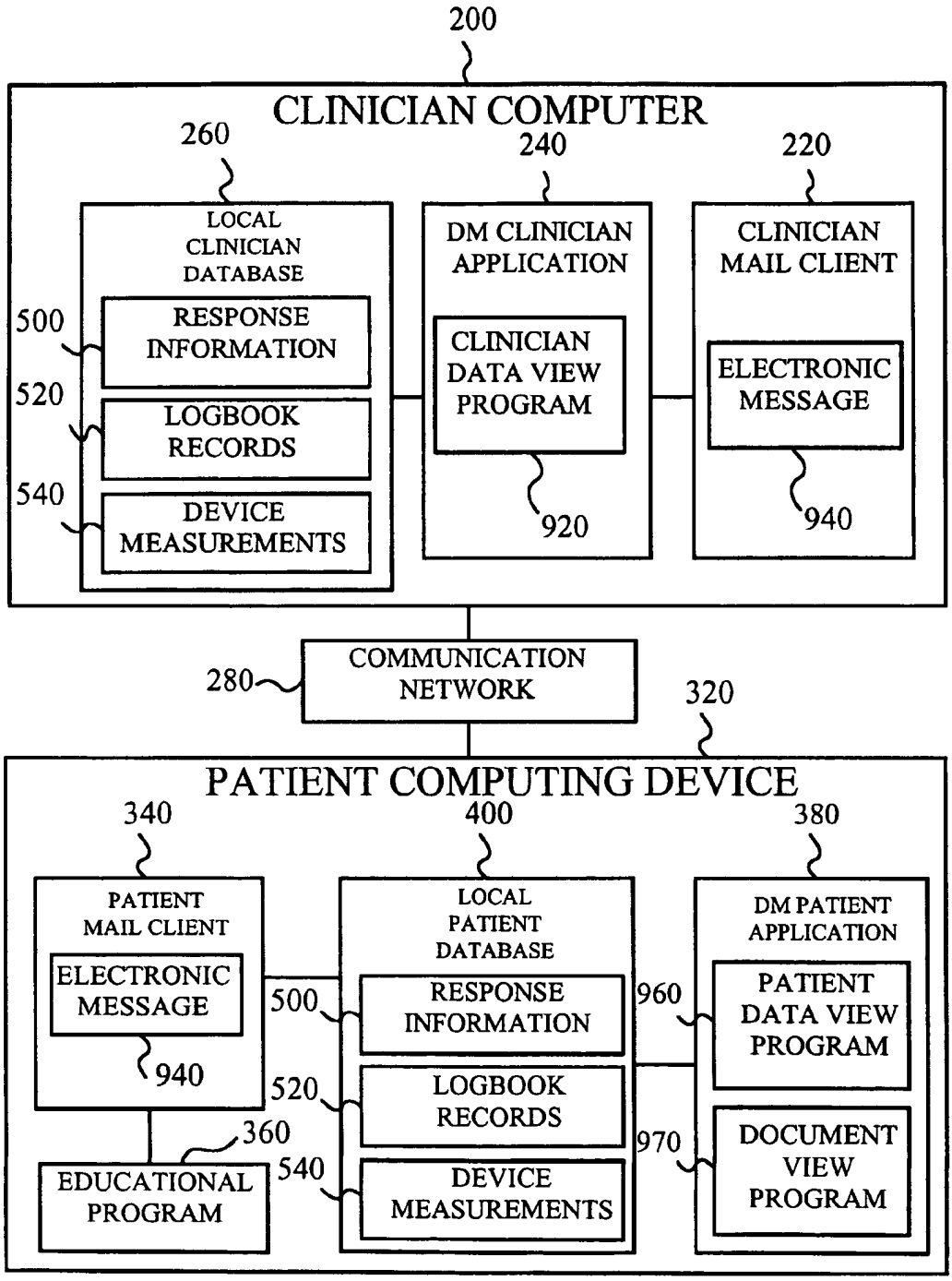

200
CLINICIAN COMPUTER
260
LOCAL CLINICIAN DATABASE
500
RESPONSE INFORMATION
520
LOGBOOK RECORDS
540
DEVICE MEASUREMENTS
240
DM CLINICIAN APPLICATION
CLINICIAN DATA VIEW PROGRAM
920
220
CLINICIAN MAIL CLIENT
ELECTRONIC MESSAGE
940
280
COMMUNICATION NETWORK
320
PATIENT COMPUTING DEVICE
340
PATIENT MAIL CLIENT
ELECTRONIC MESSAGE
940
360
EDUCATIONAL PROGRAM
400
LOCAL PATIENT DATABASE
500
RESPONSE INFORMATION
520
LOGBOOK RECORDS
540
DEVICE MEASUREMENTS
380
DM PATIENT APPLICATION
960
PATIENT DATA VIEW PROGRAM
970
DOCUMENT VIEW PROGRAM

FIG. 9

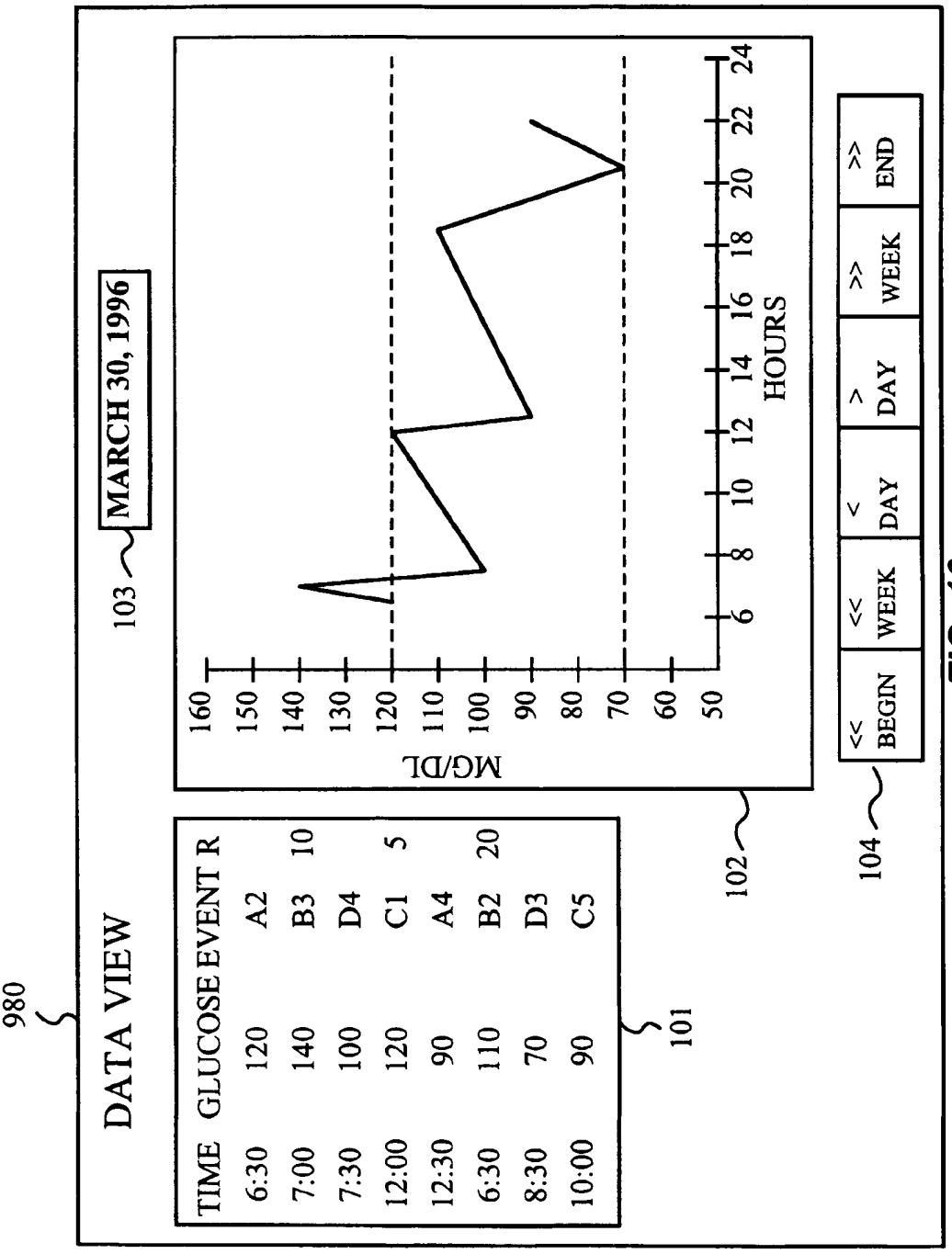

980
DATA VIEW
103
MARCH 30, 1996
TIME GLUCOSE EVENT R
6:30 120 A2
7:00 140 B3 10
7:30 100 D4
12:00 120 C1 5
12:30 90 A4
6:30 110 B2 20
8:30 70 D3
10:00 90 C5
101
102
MG/DL
160 150 140 130 120 110 100 90 80 70 60 50
HOURS
6 8 10 12 14 16 18 20 22 24
104
<< BEGIN
<< WEEK
< DAY
> DAY
>> WEEK
>> END

FIG. 10

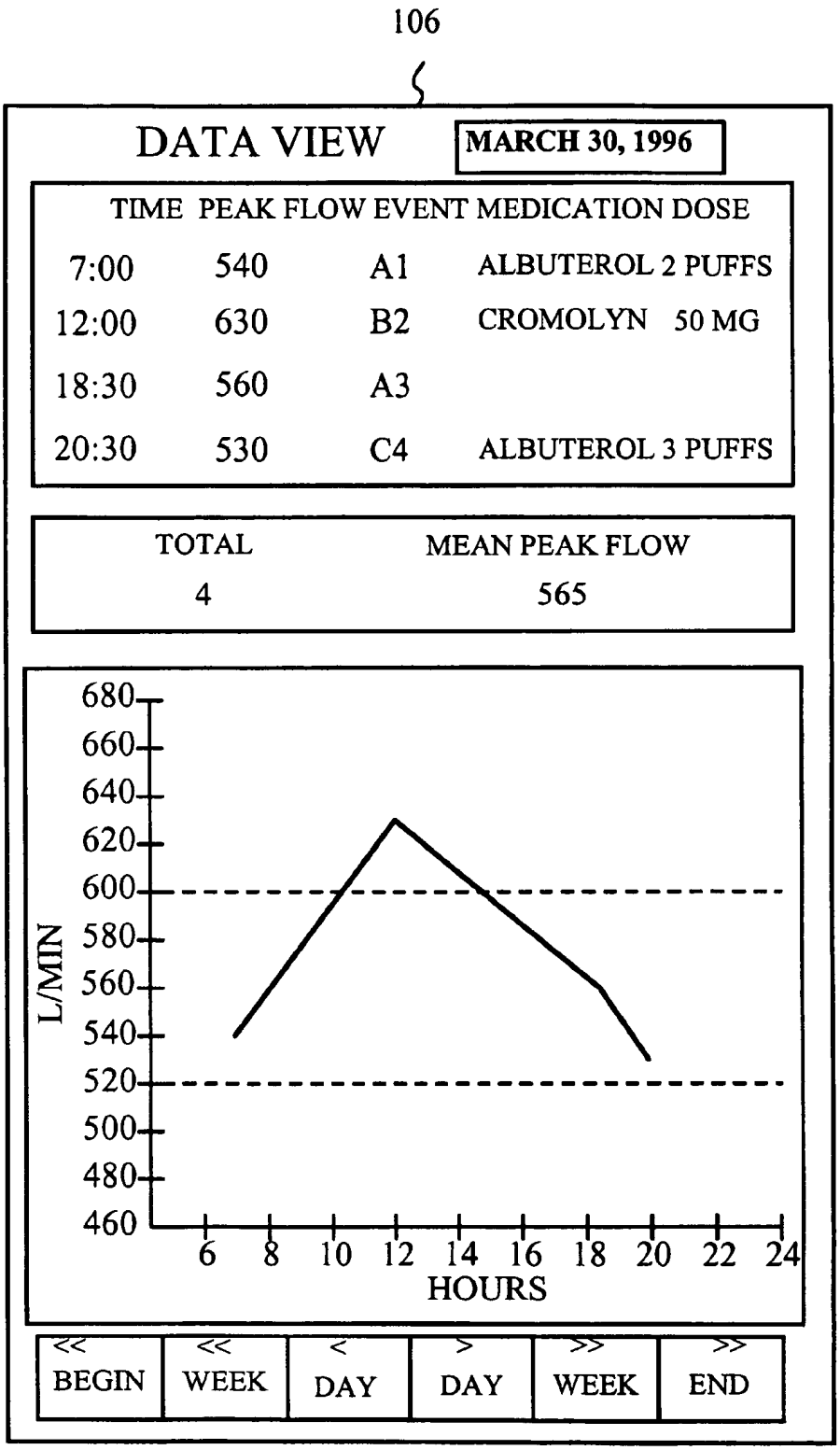

106
DATA VIEW
MARCH 30, 1996
TIME PEAK FLOW EVENT MEDICATION DOSE
7:00 540 A1 ALBUTEROL 2 PUFFS
12:00 630 B2 CROMOLYN 50 MG
18:30 560 A3
20:30 530 C4 ALBUTEROL 3 PUFFS
TOTAL
4
MEAN PEAK FLOW
565
L/MIN
680
660
640
620
600
580
560
540
520
500
480
460
6 8 10 12 14 16 18 20 22 24
HOURS
<< BEGIN
<< WEEK
< DAY
> DAY
>> WEEK
>> END

FIG. 11

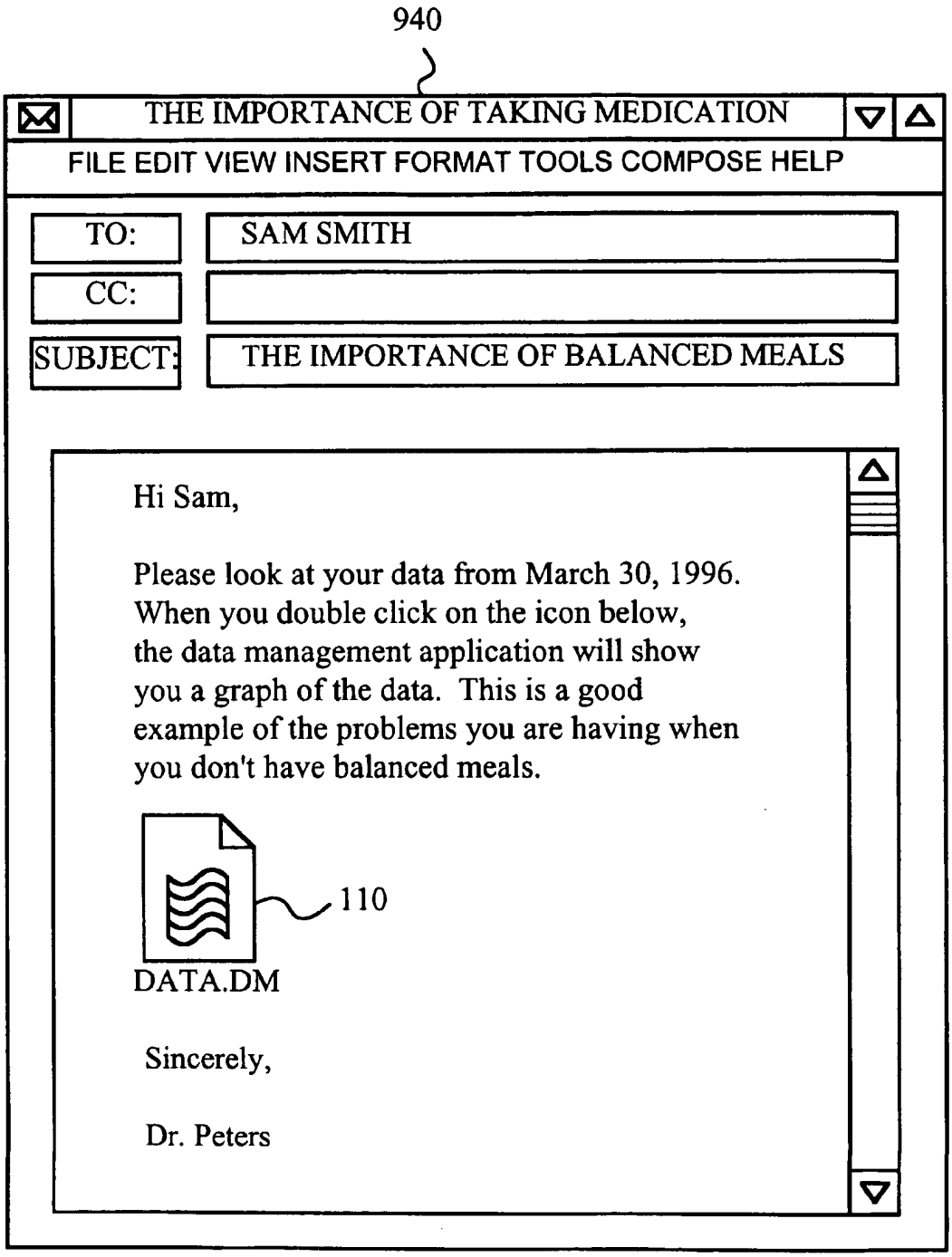

940
THE IMPORTANCE OF TAKING MEDICATION
FILE EDIT VIEW INSERT FORMAT TOOLS COMPOSE HELP
TO:
SAM SMITH
CC:
SUBJECT:
THE IMPORTANCE OF BALANCED MEALS
Hi Sam,
Please look at your data from March 30, 1996. When you double click on the icon below, the data management application will show you a graph of the data. This is a good example of the problems you are having when you don't have balanced meals.
110
DATA.DM
Sincerely,
Dr. Peters

FIG. 12

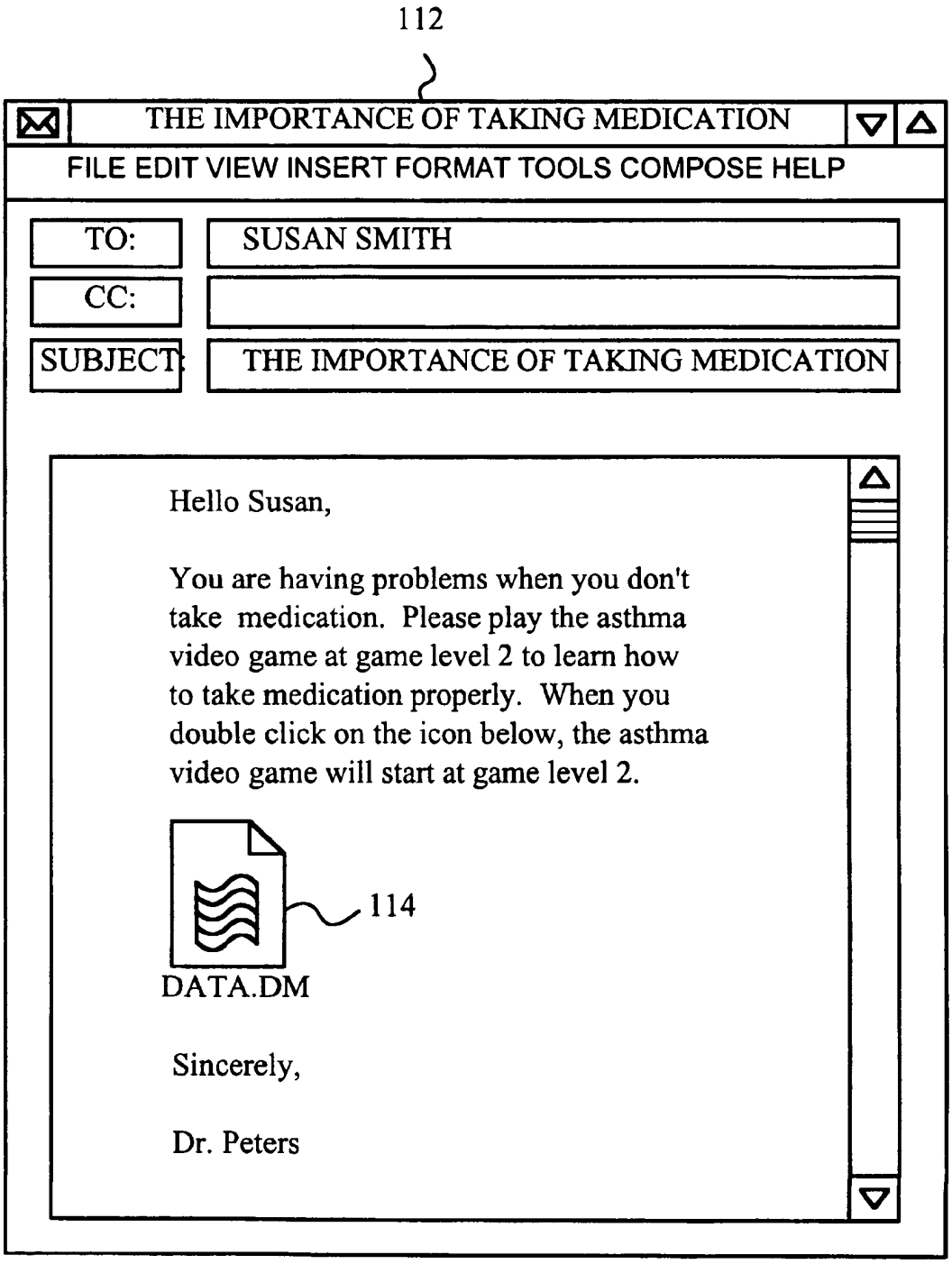

112
THE IMPORTANCE OF TAKING MEDICATION
FILE EDIT VIEW INSERT FORMAT TOOLS COMPOSE HELP
TO:
SUSAN SMITH
CC:
SUBJECT:
THE IMPORTANCE OF TAKING MEDICATION
Hello Susan,
You are having problems when you don't take medication. Please play the asthma video game at game level 2 to learn how to take medication properly. When you double click on the icon below, the asthma video game will start at game level 2.
114
DATA.DM
Sincerely,
Dr. Peters

FIG. 13

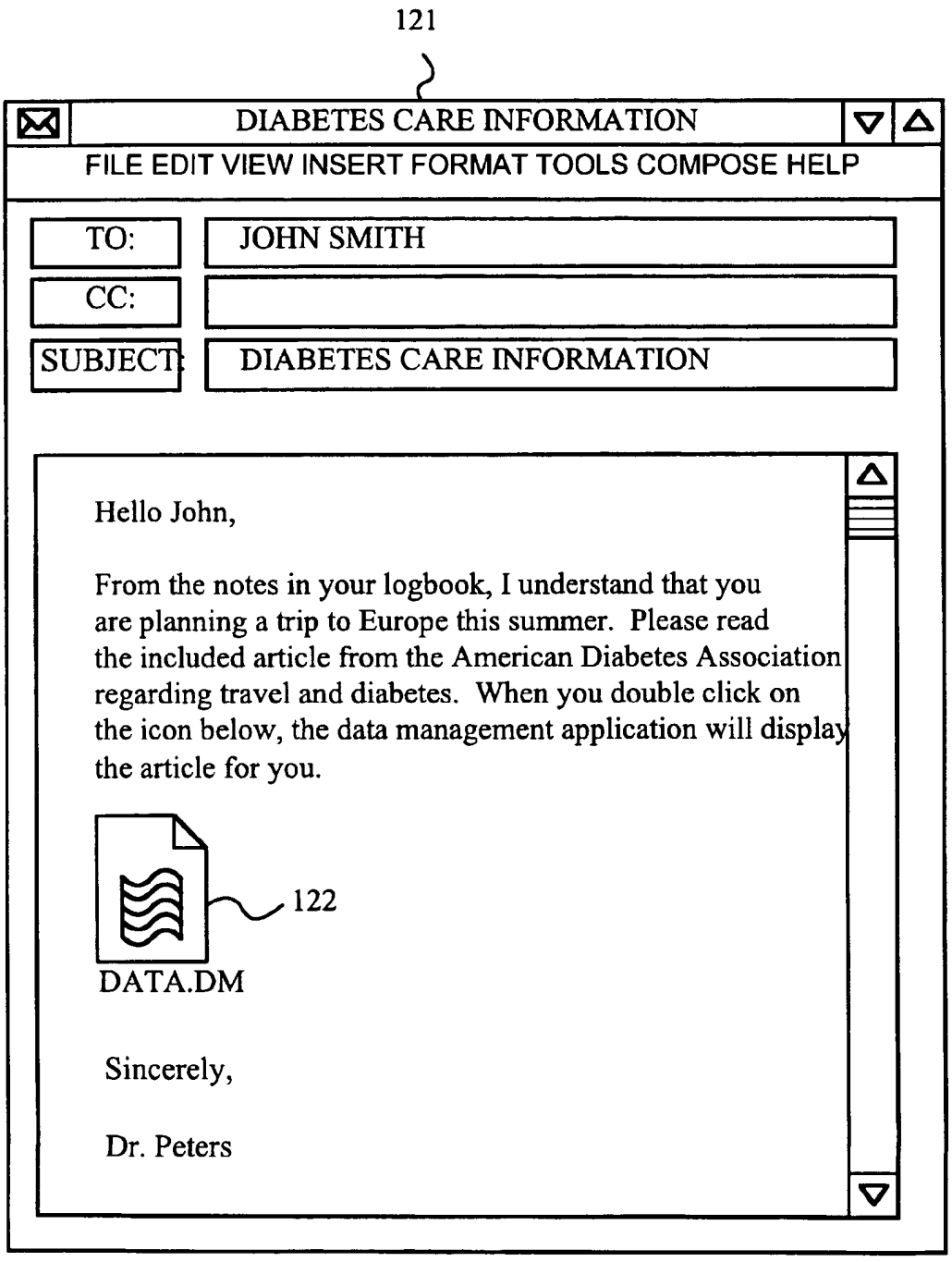

121
DIABETES CARE INFORMATION
FILE EDIT VIEW INSERT FORMAT TOOLS COMPOSE HELP
TO:
JOHN SMITH
CC:
SUBJECT:
DIABETES CARE INFORMATION
Hello John,
From the notes in your logbook, I understand that you are planning a trip to Europe this summer. Please read the included article from the American Diabetes Association regarding travel and diabetes. When you double click on the icon below, the data management application will display the article for you.
122
DATA.DM
Sincerely,
Dr. Peters

FIG. 14

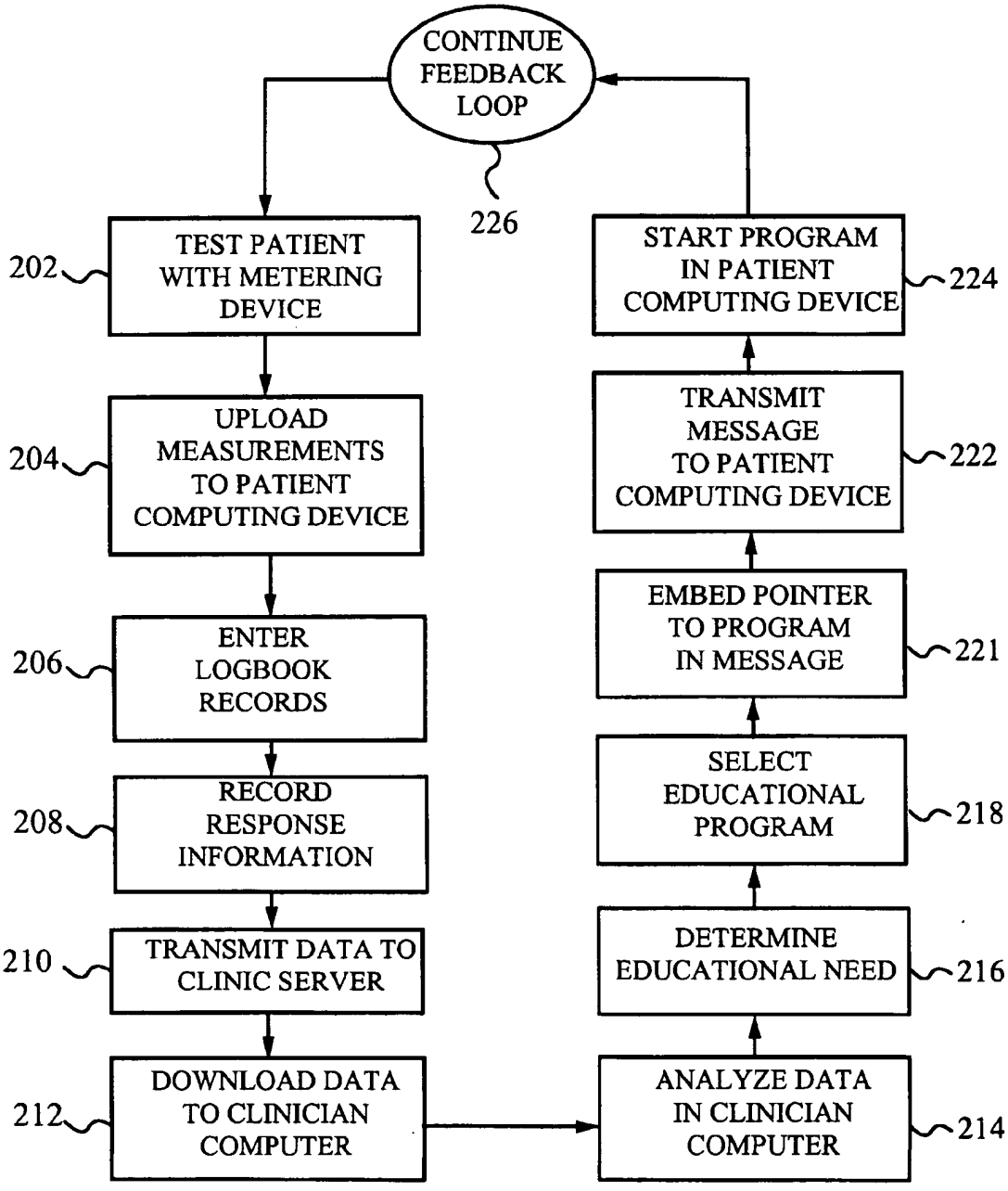

CONTINUE FEEDBACK LOOP
226
202
TEST PATIENT WITH METERING DEVICE
204
UPLOAD MEASUREMENTS TO PATIENT COMPUTING DEVICE
206
ENTER LOGBOOK RECORDS
208
RECORD RESPONSE INFORMATION
210
TRANSMIT DATA TO CLINIC SERVER
212
DOWNLOAD DATA TO CLINICIAN COMPUTER
214
ANALYZE DATA IN CLINICIAN COMPUTER
216
DETERMINE EDUCATIONAL NEED
218
SELECT EDUCATIONAL PROGRAM
221
EMBED POINTER TO PROGRAM IN MESSAGE
222
TRANSMIT MESSAGE TO PATIENT COMPUTING DEVICE
224
START PROGRAM IN PATIENT COMPUTING DEVICE

FIG. 15

HEALTH MANAGEMENT PROCESS CONTROL SYSTEM

RELATED APPLICATIONS

This is a continuation-in-part of application Ser. No. 08/481,925, filed Jun. 7, 1995, now abandoned which is a continuation-in-part of application Ser. No. 07/977,323, filed Nov. 17, 1992, and issued as U.S. Pat. No. 5,307,263. This application is also a continuation-in-part of application Ser. No. 08/666,242, filed Jun. 20, 1996, now abandoned.

BACKGROUND

1. Field of the Invention

The present invention relates to the field of health management, and in particular to a system and method for remotely monitoring a patient and for training the patient to comply with a treatment plan for a health condition.

2. Description of the Prior Art

In recent years, an increasing number of healthcare providers have initiated outpatient or home healthcare programs for their patients. The potential benefits of these home healthcare programs are particularly good for chronically ill patients, such as those suffering from asthma or diabetes, who must treat their diseases on a daily basis. However, the success of these home healthcare programs is currently limited by the ability of healthcare providers to assess, monitor and train patients to comply with treatment plans for their health conditions.

Many systems have been developed for remotely monitoring a patient's compliance with a prescribed medication plan. For example, U.S. Pat. No. 5,390,238 issued to Kirk et al. on Feb. 14, 1995 discloses a home healthcare and communication support system. The system includes a health support unit located in the patient's home for monitoring and supporting a patient. The health support unit is networked to a remote monitoring terminal for continuous remote monitoring of the patient. The health support unit includes a medication controller for measuring the patient's medicine compliance and a communications module for communicating with an operator at the monitoring terminal. The health support is further networked to the patient's healthcare provider to allow the healthcare provider access to the patient's medicine compliance data.

A similar system for monitoring a patient's medicine compliance is described in U.S. Pat. No. 5,016,172 issued to Dessertine on May 14, 1991. The system includes an automatic medicine compliance monitoring device for measuring the patient's actual medicine consumption. The monitoring device is connected to a patient computing device for recording the patient's medicine consumption. The patient computing device is further connected to a remote monitoring terminal for displaying the patient's medicine compliance to a healthcare provider. The system optionally includes a second monitoring device for monitoring a physical condition of the patient, such as heart rate, blood pressure, blood glucose, or respiration.

Although the systems described by Kirk and Dessertine allow remote monitoring of a patient's health condition and medicine compliance, they have no mechanism for ensuring patient compliance with a treatment plan. Further, these systems are not directed at providing the patient guidelines for treating a health condition. They are simply designed to monitor the patient from a remote location.

Numerous systems have also been developed for prompting a patient take prescribed doses of medication in addition

to remotely monitoring the patient's health condition. For example, U.S. Pat. No. 5,501,231 issued to Kaish on Mar. 26, 1996 describes a patient-operated, hand-held system for testing and recording peak flow rates of an asthma patient. The system includes a peak flow meter for measuring the patient's peak flow rates and an alarm for prompting the patient to take a prescribed dose of medication. In using the system, the patient records his or her peak flow rates over a predetermined period of time, typically fifteen days to six months, before returning the system to a doctor for recovery of the peak flow data. At this time, the doctor may optionally reprogram the system with new alarm times and prescribed medicine doses.

Although the system described by Kaish has the advantage of prompting a patient to take medication, it lacks any mechanism for training the patient to actually comply with the prompts. The system is limited to issuing preprogrammed medicine instructions to the patient without teaching the patient why or how to follow the instructions. Further, the system cannot identify any problems the patient is experiencing in following a treatment plan for his or her health condition or teach the patient how to solve the problems. As a result, the patient may not be able to comply with the prescribed treatment plan, severely limiting the effectiveness of this home healthcare system. Additionally, the system described by Kaish does not permit continuous feedback between the doctor and patient for ongoing adjustment of the treatment plan.

Another system for remotely monitoring a patient and for prompting a patient to take a prescribed dose of medication is disclosed in U.S. Pat. No. 4,731,726 issued to Allen on Mar. 15, 1988. Allen describes a diabetes management system having a blood glucose meter for measuring a patient's blood glucose levels and for sending the blood glucose measurements to a physician. The system further includes a user interface for entering in the system data relating to the patient's medication usage, exercise routine, and dietary intake. Based on the entered data, the system calculates a recommended insulin dose for the patient using a physician prescribed algorithm stored in its memory.

Allen's system suffers from the same disadvantage as Kaish's system in failing to train the patient to comply with the prescribed treatment plan. The system is limited to issuing dosage instructions based on a preprogrammed algorithm without identifying any problems the patient is experiencing with the diabetes program or teaching the patient how to solve the problems. Consequently, the effectiveness of this diabetes management system is also limited.

A similar system for home management of diabetes is disclosed in U.S. Pat. No. 5,109,974 issued to Beckers on May 28, 1991. The system includes a physician computer for developing a diabetes therapy program and a patient recorder having an interface for exchanging data with the physician computer. The recorder has a blood glucose test strip for measuring the patient's blood glucose levels and a user interface for entering in the recorder data relating to the patient's insulin usage, exercise routines, and dietary intake. Using the patient data and therapy guidelines downloaded from the physician computer, the recorder calculates and displays to the patient a recommended insulin dosage, exercise plan, and diet. The recorder also receives from the physician computer new therapy guidelines developed from the patient's recorded data.

Although the diabetes management program disclosed by Beckers has the advantage of adjusting a patient's recommended therapy program based on remote monitoring of the

patient, it also has the same disadvantage as the previous systems in failing to teach the patient how to follow the prescribed treatment plan. Becker's system has no mechanism for identifying problems the patient is experiencing with the diabetes program or for teaching the patient how to solve the problems. As a result, Becker's system is also ineffective for training the patient to comply with the diabetes treatment plan.

OBJECTS AND ADVANTAGES OF THE INVENTION

In view of the above, it is an object of the present invention to provide a system and method for remotely monitoring a patient and for effectively training the patient to comply with a treatment plan for a health condition. It is another object of the invention to provide a method for teaching a patient to solve a specific problem the patient is experiencing with a treatment plan. A further object of the invention is to provide a system that allows continuous feedback between a clinician and patient for ongoing adjustment of a treatment plan.

The invention provides a new and useful system for healthcare monitoring and patient training based on a small microprocessor-based unit or a personal computer which is networked with the clinician's resources and requisite databases.

These and other objects and advantages will become more apparent after consideration of the ensuing description and the accompanying drawings.

SUMMARY OF THE INVENTION

The invention presents a system and method for remotely monitoring a patient and for training the patient to comply with a treatment plan for a health condition. The system includes a patient computing device, such as a personal computer or network terminal, for collecting data relating to the health condition. In the preferred embodiment, the data includes measurements of a physical characteristic of the health condition, such as blood glucose measurements for a diabetic patient or peak flow measurements for an asthmatic patient. Also in the preferred embodiment, the data includes measurements of a psychological characteristic of the health condition, such as the patient's knowledge, comprehension, or attitude in treating the health condition.

The system further includes a clinician computer having a data analysis program for analyzing the data to determine an educational need of the patient. The clinician computer also has a message program, such as an electronic mail program, for composing an electronic message to the patient. The electronic message contains a pointer to an educational program corresponding to the patient's educational need. The pointer is a prompt embedded in the message. When the patient selects the pointer the latter loads and executes the educational program instructions linked to the message. A communication network connects the patient computing device and the clinician computer and transmits the data and the electronic message therebetween.

A preferred method of using the system includes the steps of entering data relating to the patient's health condition into the patient computing device and transmitting the data from the patient computing device to the clinician computer via the communication network. The method further includes the steps of analyzing the data received in the clinician computer to determine an educational need of the patient and selecting an educational program corresponding to the educational need. A pointer to the selected educational program is then embedded in an electronic message to the patient. The electronic message is transmitted through the communication network from the clinician computer to the patient computing device.

The educational program is started on the patient computing device when the patient selects the embedded pointer in the electronic message. As the patient works with the educational program, new data relating to the patient's health condition is collected in the patient computing device and transmitted to the clinician computer for analysis. With this continuos feedback loop between the patient and clinician, the clinician is able to monitor the patient's progress and effectively train the patient to comply with the treatment plan.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1A** is a block diagram that illustrates a healthcare monitoring system arranged in accordance with the invention.

FIG. **1B** is a schematic block diagram illustrating an alternative healthcare monitoring system arranged in accordance with the invention.

FIG. **2** diagrammatically illustrates monitoring systems constructed in accordance with the invention connected in signal communication with a remotely located computing facility which includes provision for making the data supplied by the monitoring system of the invention available to a designated healthcare professional and/or for providing data and instructions to the system user.

FIG. **3** is a schematic block diagram of the main components of a health management process control system according to the invention.

FIG. **4** is a schematic block diagram illustrating the entering of patient data into a patient computing device according to the method of the invention.

FIGS. **5–6** are sample logbook entry screens appearing on the patient computing device of FIG. **4**.

FIGS. **7–8** are sample medication entry screens appearing on the patient computing device of FIG. **4**.

FIG. **9** is a schematic block diagram illustrating the transmitting of an electronic message in response to an analysis of the patient data of FIG. **4** according to the method of the invention.

FIGS. **10–11** are sample data views appearing on the screen of a clinician computer and on the screen of the patient computing device of FIG. **4**.

FIGS. **12–14** are sample electronic messages sent from a doctor to a patient according to the method of the invention.

FIG. **15** is a flow chart illustrating steps included in the method of the invention.

DESCRIPTION

FIG. **1A** depicts a self-care health monitoring system arranged in accordance with the invention. In the arrangement shown in FIG. **1A**, a data management unit **10** is electrically interconnected with a computing device such as a computer or a handheld microprocessor-based unit **12** via a cable **14**. In the depicted arrangement, data management unit **10** also is electrically interconnected with a blood glucose monitor **16** of the type capable of sensing blood glucose level and producing an electrical signal representative thereof.

Although FIG. **1A** illustrates blood glucose monitor **16** as being connected to data management unit **10** by a cable **18**,

it may be preferable to construct blood glucose monitor **16** as a plug-in unit that is placed in a recess or other suitable opening or slot in data management unit **10**.

Also shown in FIG. **1**A are two additional monitoring devices **20** and **22**, which are electrically connected for serial data communication with data management unit **10** via cables **24** and **26**, respectively. Monitoring units **20** and **22** of FIG. **1**A represent devices other than blood glucose monitor **16** that can be used to configure the invention for self-care health monitoring applications other than (or in addition to) diabetes care. For example, as is indicated in FIG. **1**A, the monitoring device **20** can be a peak-flow meter that provides a digital signal representative of the airflow that results when a person suffering from asthma or another chronic respiratory affliction expels a breath of air through the meter. As is indicated by monitor **22** various other devices can be provided for monitoring conditions such as blood pressure, pulse, and body temperature to thereby realize systems for self-care monitoring and control of conditions such as hypertension, certain heart conditions and various other afflictions and physical conditions. Upon understanding the hereinafter discussed aspects and features of the invention it will be recognized that the invention is easily implemented for these and other types of healthcare monitoring.

As is shown in FIG. **1**A, handheld microprocessor unit **12** includes a display screen **28** and a plurality of switches or keys (**30**, **32**, **34**, **36**, and **38**), which are mounted on a housing **40**. Located in the interior of housing **40**, but not shown in FIG. **1**A, are a microprocessor, memory circuits, and circuitry that interfaces switches **30**, **32**, **34**, **36** and **38** with the microprocessor.

Stored in the memory of program microprocessor unit **12** is a set of program instructions that establishes a data protocol that allows microprocessor unit **12** to perform digital data signal processing and generate desired data or graphics for display on display unit **28** when a program cartridge **42** is inserted in a slot or other receptacle in housing **40**. That is, program cartridge **42** includes read-only memory units (or other memory means such as battery-powered random access memory) which store program instructions and data that adapt handheld microprocessor **12** for operation in a blood glucose monitoring system. More specifically, when the instructions and data of program cartridge **42** are combined with program instructions and data included in the internal memory circuits of microprocessor unit **12**, microprocessor unit **12** is programmed for processing and displaying blood glucose information in the manner described below and additional monitors **22** to provide health monitoring for asthma and various other previously mentioned chronic conditions. In each case, the plurality of switches or keys **30**, **32**, **34**, **36**, and **38** are selectively operated to provide signals that result in pictorial and/or alphanumeric information being displayed by display unit **42**.

Various devices are known that meet the above-set forth description of microprocessor unit **12**. For example, compact devices are available in which the plurality of keys allows alphanumeric entry and internal memory is provided for storing information such as names, addresses, phone numbers, and an appointment calendar. Small program cartridges or cards can be inserted in these devices to program the device for various purposes such as the playing of games. More recently, less compact products that have more extensive computational capability and are generally called "palm top computers" have been introduced into the marketplace. These devices also can include provision for programming the device by means of an insertable program card or cartridge. Alternatively, the program can be loaded into their memory from a network or via a modem connection. A person of average skill in the art will appreciate that, there exist other suitable methods for loading programs into suitable computer devices.

Another advantage of realizing handheld microprocessor unit **12** in the form of a compact video game system is the relatively simple, yet versatile arrangement of switches that is provided by such a device. For example, a compact video game system includes a control pad **30** that allows an object displayed on display unit **42** to be moved in a selected direction (i.e., up-down or left-right). As also is indicated in FIG. **1**A, compact video game systems typically provide two pair of distinctly-shaped push button switches. A pair of spaced-apart circular push button switches (**36** and **38**) and a pair of elongate switches (**32** and **34**) are provided. The functions performed by the two pairs of switches is dependent upon the program instructions contained in each program cartridge **42**.

Yet another advantage of utilizing a compact video game system for handheld microprocessor-based unit **12** of FIG. **1**A is the widespread popularity and low cost of such units. In this regard, manufacture and sale of a data management unit **10**, blood glucose monitor **16** and program cartridge **42** that operate in conjunction with a compact microprocessor-based video allows the self-care health monitoring system of FIG. **1**A to be manufactured and sold at a lower cost than could be realized in an arrangement in which handheld unit **12** is designed and manufactured solely for use in the system.

An even further advantage of using a compact video game system for handheld microprocessor **12** is that such video game systems include means for easily establishing the electrical interconnection provided by cable **14**. In particular, such compact video game systems include a connector **40** mounted to the game unit housing and a cable that can be connected between the connectors of two video game units to allow interactive operation of the two interconnected units (i.e., to allow contemporaneous game play by two players or competition between players as they individually play identical but separate games). The cable supplied with handheld microprocessor unit **12** can be used as cable **14** to establish serial data communication between the handheld microprocessor unit **12** (compact video game system) and data management unit **10**.

Depending upon the operational mode selected by the user, data is supplied to data management unit **10** by blood glucose monitor **16**, by additional monitors (**20** and **22** in FIG. **1**A) or any interconnected computers or data processing facility (such as the hereinafter described user's computer **48** and clearinghouse **54**). During such operation, mode switches **30**, **32**, **34**, **36** and **38** are selectively activated so that signals are selectively coupled to microprocessor unit **12** and processed in accordance with program instructions stored in program cartridge **42**. The signal processing performed by microprocessor unit **12** results in the display of alphanumeric, symbolic, or graphic information on the video game display **28**, which allow the user to control system operation and obtain desired test results and other information.

Although the above-discussed advantages apply to use of the invention by all age groups, employing a compact video game system in the practice of the invention is of special significance in monitoring a child's blood glucose or other health parameters. Children and young adults are familiar

with compact video game systems. Thus, children will accept a health monitoring system incorporating a compact video game system more readily than a traditional system, even an embodiment of the invention that uses a different type of handheld microprocessor unit. Moreover, an embodiment of the invention that functions in conjunction with a compact video game system can be arranged to motivate children to monitor themselves more closely than they might otherwise by incorporating game-like features and/or animation in system instruction and test result displays. Similarly, the program instructions can be included in program cartridges **41**, **42** and **43** (or additional cartridges) that allow children to select game-like displays that help educate the child about his or her condition and the need for monitoring.

With continued reference to FIG. 1A, data management unit **10** includes a data port **44** that allows communication between data management unit **10** and a personal computer **48** (or other programmable data processor). Data port **44** is, for example, an RS-232 connection that allows serial data communication between data management unit **10** and persona: computer **48**. In the practice of the invention, personal computer **48** can be used to supplement data management unit **10** by, for example, performing more complex analyses of blood glucose and other data that has been supplied to and stored in the memory circuits of data management unit **10**. with respect to embodiments of the invention configured for use by a child, personal computer **48** can be used by a parent or guardian to review and analyze the child's progress and to produce printed records for subsequent review by a healthcare professional.

Alternatively, personal computer **48** can be used to supply data to data management unit **10** that is not conveniently supplied by using handheld microprocessor switches **30**, **32**, **34**, **36** and **38** as an operator interface to the system of FIG. 1A. For example, some embodiments of the invention may employ a substantial amount of alphanumeric information that must be entered by the system user. Although it is possible to enter such data by using switches **30**, **32**, **34**, **36** and **38** in conjunction with menus and selection screens displayed on display screen **28** of FIG. 1A, it may be more advantageous to use a device such as personal computer **48** for entry of such data. However, if personal computer **48** is used in this manner, some trade-off of system features may be required because data management unit **10** must be temporarily interconnected with personal computer **48** during these operations. That is, some loss of system mobility might result because a suitably programmed personal computer would be needed at each location at which data entry or analysis is to occur. Of course, it will be recognized by a person of average skill in the art that in certain embodiments personal computer **48** can absorb the entire functionality of unit **12** and data management unit **10**. A system based on computer **48** only may be more successful with adult patients or when the data to be displayed is very complicated and requires the entire computer screen.

As is indicated in FIG. 1A, data management unit **10** of the currently preferred embodiments of the invention also includes a modem that allows data communication between data management unit **10** and an information service, computing facility or clearinghouse **54** via a conventional telephone line **50** in and a modem **52** that interconnects clearinghouse **54** via telephone line **50**.

Clearinghouse **54** facilitates communication between a user of the system and his or her healthcare professional and can provide additional services such as updating system software or downloading specific programs to the user. In fact, in one embodiment clearing house **54** is the computer used by the clinician. As is indicated by facsimile machine **55** of FIG. 1A, a primary function of clearinghouse **54** is providing the healthcare professional with standardized reports **56**, which indicate both the current condition and condition trends of the system user. Although a single facsimile machine **55** is shown in FIG. 1A, it will be recognized that numerous healthcare professionals (and hence facsimile machine **55**) can be connected in signal communication with a clearinghouse **54**. In this situation each healthcare professional may have his or her own clinician computer linked to clearinghouse **54** according to methods well known in the art.

Regardless of whether a compact video game system, another type of commercially available handheld microprocessor-based unit, or a specially designed unit is used, the system of FIG. 1A provides a self-care blood glucose monitoring system in which program cartridge **42**: (a) adapts handheld microprocessor unit **12** for displaying instructions for performing the blood glucose test sequence and associated calibration and test procedures; (b) adapts handheld microprocessor unit **12** for displaying (graphically or alphanumerically) statistical data such as blood glucose test results taken during a specific period of time (e.g., a day, week, etc.); (c) adapts handheld microprocessor unit **12** for supplying control signals and signals representative of food intake or other useful information to data management unit **10**; (d) adapts handheld microprocessor unit **12** for simultaneous graphical display of blood glucose levels with information such as food intake; and, (e) adapts handheld microprocessor unit **12** for displaying information or instructions from a healthcare professional that are coupled to data management unit **10** from a clearinghouse **54**. In the event that computer **48** absorbs all of the functions of unit **12** and data management unit **10**, cartridge **42** or appropriate software is communicated directly to computer **48** instead. Computer **48** then performs all of the above functions. The manner in which the arrangement of FIG. 1A implements the above-mentioned functions and others can be better understood with reference to FIG. **2** discussed further below.

Alternatively, the functionality of handheld unit **12**, computer **48**, data management unit **10** and modem **52** can be replaced by a single integrated device. Such an embodiment is shown in FIG. 1B, by a schematic block diagram of an integrated device **1**. Device **1** includes a microprocessor **2** and a memory **3** connected to microprocessor **2**. Memory **3** is preferably a non-volatile memory, such as a serial EEPROM. Memory **3** stores programs or script programs received from clearing house **54**, measurements received from monitoring devices **16**, **20** or **22**, and the patient's responses. Microprocessor **2** also includes built-in read only memory (ROM) which stores firmware for controlling the operation of apparatus **1**. The firmware includes a script interpreter used by microprocessor **2** to execute the script programs. The script interpreter interprets script commands which are executed by microprocessor **2**. Specific techniques for interpreting and executing script commands in this manner are well known in the art.

Microprocessor **2** is preferably connected to memory **3** using a standard two-wire I^2C interface. Microprocessor **2** is also connected to user input buttons **4**, LED **5**, a clock **6**, and a display driver **7**. Clock **6** indicates the current date and time to microprocessor **2**. For clarity of illustration, clock **6** is shown as a separate component, but is preferably built into microprocessor **2**. Display driver **7** operates under the control of microprocessor **2** to display information on display **8**. Microprocessor **2** is preferably a PIC 16C65 processor

which includes a universal asynchronous receiver transmitter (UART) 9. UART 9 is for communicating with modem 52 and a device interface 11. A CMOS switch 13 under the control of microprocessor 2 alternately connects modem 52 and interface 11 to UART 9.

Modem 52 is connected to a telephone jack 15 through modem jack 17. Modem 52 is for exchanging data with clearing house 54 through telephone line or any other suitable communication network 50. The data includes programs, e.g., script programs which are received from the server as well as responses to queries, device measurements, any required script identification codes, and the patient's unique identification code which modem 52 transmits to the clearing house. Modem 52 is preferably a complete 28.8 K modem commercially available from Cermetek, although any suitable modem may be used.

Device interface 11 is connected to device jacks 19A, 19B, and 19C. Device interface 11 is for interfacing with monitoring devices 16, 20, 22 which can include blood glucose meters, respiratory flow meters, blood pressure cuffs, weight scales, pulse rate monitors or any other suitable patient monitoring devices. Device interface 11 operates under the control of microprocessor 2 to collect measurements from the monitoring devices and to output the measurements to microprocessor 2 for storage in memory 3. In the preferred embodiment, interface 11 is a standard RS232 interface. In alternative embodiments, apparatus 1 may include multiple device interfaces to accommodate monitoring devices which have different connection standards.

As shown in FIG. 2, clearinghouse 54 receives data from a plurality of self-care microprocessor-based healthcare systems of the type shown in either FIG. 1A or FIG. 1B, with the individual self-care health monitoring systems being indicated in FIG. 2 by reference numeral 58. Preferably, the data supplied to clearinghouse 54 by each individual self-care health monitoring system 58 consists of "raw data," i.e., test results and related data that was stored in memory circuits of data management unit 10, without further processing by data management unit 10. For example, with respect to the arrangement shown in FIG. 1A or FIG. 1B, blood glucose test results and associated data such as food intake information, medication dosage and other such conditions are transmitted to clearinghouse 54 and stored with a digitally encoded signal that identifies both the source of the information (i.e., the system user or patient) and those having access to the stored information (i.e., the system user's doctor or other healthcare professional).

As shall be recognized upon understanding the manner in which it operates, clearinghouse 54 can be considered to be a central server for the various system users 58 and each healthcare professional 60. Thus, clearinghouse 54 includes conventionally arranged and interconnected digital processing equipment, i.e., digital signal processor 57 which receives digitally encoded information from user 58 or healthcare professional 60; processes the information as required; stores the information (processed or unprocessed) in memory if necessary; and transmits the information to an intended recipient (i.e., user 58 or healthcare professional 60).

In FIG. 2, rectangular outline 60 represents one of numerous remotely located healthcare professionals who can utilize clearinghouse 54 and the arrangement described relative to FIG. 1A or FIG. 1B in monitoring and controlling patient healthcare programs. Shown within outline 60 is a computer 62 (e.g., personal computer), which is coupled to clearinghouse 54 by means of a modem (not shown in FIG. 2) and a telephone line 64. Also shown in FIG. 2 is the previously mentioned facsimile machine 55, which is coupled to clearinghouse 54 by means of a second telephone line 68. Using the interface unit of computer 62 (e.g., a keyboard or pointing device such as a mouse), the healthcare professional can establish data communication between computer 62 and clearinghouse 54 via telephone line 64. Once data communication is established between computer 62 and clearinghouse 54, patient information can be obtained from clearinghouse 54 in a manner similar to the manner in which subscribers to various database services access and obtain information.

In particular, the healthcare professional can transmit an authorization code to clearinghouse 54 that identifies the healthcare professional as an authorized user of the clearinghouse and, in addition, can transmit a signal representing the patient for which healthcare information is being sought. As is the case with conventional database services and other arrangements, the identifying data is keyed into computer 62 by means of a conventional keyboard (not shown in FIG. 2) in response to prompts that are generated at clearinghouse 54 for display by the display unit of computer 62 (not shown in FIG. 2).

Depending upon the hardware and software arrangement of clearinghouse 54 and selections made by the healthcare professional via computer 62, patient information can be provided to the healthcare professional in different ways. For example, computer 62 can be operated to access data in the form that it is stored in the memory circuits of clearinghouse 54 (i.e., raw data that has not been processed or altered by the computational or data processing arrangements of clearinghouse 54). Such data can be processed, analyzed, printed and/or displayed by computer 62 using commercially available or custom software. On the other hand, various types of analyses may be performed by clearinghouse 54 with the results of the analyses being transmitted to the remotely located healthcare professional 60. For example, clearinghouse 54 can process and analyze data in a manner identical to the processing and analysis provided by the self-care monitoring system of FIG. 1A or FIG. 1B. With respect to such processing and any other analysis and processing provided by clearinghouse 54, results expressed in alphanumeric format can be sent to computer 62 via telephone line 64 and the modem associated with computer 62, with conventional techniques being used for displaying and/or printing the alphanumeric material for subsequent reference.

The arrangement of FIG. 2 also allows the healthcare professional to send messages and/or instructions to each patient via computer 62, telephone line 64, and clearinghouse 54. In particular, clearinghouse 54 can be programmed to generate a menu that is displayed by computer 62 and allows the healthcare professional to select a mode of operation in which information is to be sent to clearinghouse 54 for subsequent transmission to a user of the system described relative to FIG. 1A or FIG. 1B. This same menu (or related submenus) can be used by the healthcare professional to select one or more modes of operation of the above-described type in which either unmodified patient data or the results of data that has been analyzed by clearinghouse 54 is provided to the healthcare provider via computer 62 and/or facsimile machine 55.

Operation of the arrangement of FIG. 2 to provide the user of the invention with messages or instructions such as changes in medication or other aspects of the healthcare program, e.g., instructional programs, is similar to the operation that allows the healthcare professional to access data sent by a patient, i.e., transmitted to clearinghouse 54 by a

data management unit **10** of FIG. **1**A or FIG. **1**B. The process differs in that the healthcare professional enters the desired message or instruction via the keyboard or other interface unit of computer **62**. Once the data is entered and transmitted to clearinghouse **54**, it is stored for subsequent transmission to the user for whom the information or instruction is intended.

With respect to transmitting stored messages or instructions to a user of the invention, at least two techniques are available. The first technique is based upon the manner in which operational modes are selected in the practice of the invention. Specifically, in the currently preferred embodiments of the invention, program instructions that are stored in data management unit **10** and program cartridge **42** cause the system of FIG. **1**A or FIG. **1**B to generate menu screens which are displayed by display unit **28** of microprocessor unit **12**. The menu screens allow the system user to select the basic mode in which the system is to operate and, in addition, allow the user to select operational subcategories within the selected mode of operation. Various techniques are known to those skilled in the art for displaying and selecting menu items. For example, in the practice of this invention, one or more main menus can be generated and displayed which allow the system user to select operational modes that may include: (a) a monitor mode (e.g., monitoring of blood glucose level); (b) a display mode (e.g., displaying previously obtained blood glucose test results or other relevant information); (c) an input mode (e.g., a mode for entering data such as providing information that relates to the healthcare regimen, medication dosage, food intake, etc.); and, (d) a communications mode (for establishing a communication link between data management unit **10** and personal computer **48** of FIG. **1**A or FIG. **1**B; or between data management unit **10** and a remote computing facility such as clearinghouse **54** of FIG. **2**).

In embodiments of the invention that employ a compact video game system for handheld microprocessor unit **12**, the selection of menu screens and the selection of menu screen items preferably is accomplished in substantially the same manner as menu screens and menu items are selected during the playing of a video game. For example, the program instructions stored in data management unit **10** and program cartridge **42** of the arrangement of FIG. **1**A or FIG. **1**B can be established so that a predetermined one of the compact video game switches (e.g., switch **32**) allows the system user to select a desired main menu in the event that multiple main menus are employed. When the desired main menu is displayed, operation by the user of control pad **30** allows a cursor or other indicator that is displayed on the menu to be positioned adjacent to or over the menu item to be selected. Activation of a switch (e.g., switch **36** of the depicted handheld microprocessor unit **12**) causes the handheld microprocessor unit **12** and/or data management unit **10** to initiate the selected operational mode or, if selection of operational submodes is required, causes handheld microprocessor unit **12** to display a submenu.

In view of the above-described manner in which menus and submenus are selected and displayed, it can be recognized that the arrangement of FIG. **1**A or FIG. **1**B can be configured and arranged to display a menu or submenu item that allows the user to obtain and display messages or instructions that have been provided by a healthcare professional and stored in clearinghouse **54**. For example, a submenu that is generated upon selection of the previously mentioned communications mode can include submenu items that allow the user to select various communication modes, including a mode in which serial data communication is established between data management unit **10** and clearinghouse **54** and data management unit **10** transmits a message status request to clearinghouse **54**. When this technique is used, the data processing system of clearinghouse **54** is programmed to search the clearinghouse memory to determine whether a message exists for the user making the request. Any messages stored in memory for that user are then transmitted to the user and processed for display on display unit **28** of handheld microprocessor unit **12**. Of course, the message may include an entire program, e.g., an instructional video. If no messages exist, clearinghouse **54** transmits a signal that causes display unit **28** to indicate "no messages." In this arrangement, clearinghouse **54** preferably is programmed to store a signal indicating that a stored message has been transmitted to the intended recipient (user). Storing such a signal allows the healthcare professional to determine that messages sent to clearinghouse **54** for forwarding to a patient have been transmitted to that patient.

In addition, the program instructions stored in data management unit **10** preferably allow the system user to designate whether received messages and instructions are to be stored in the memory of data management unit **10** for subsequent retrieval or review. In addition, in some instances it may be desirable to program clearinghouse **54** and data management unit **10** so that the healthcare professional can designate (i.e., flag) information such as changes in medication that will be prominently displayed to the user (e.g., accompanied by a blinking indicator) and stored in the memory of data management unit **10** regardless of whether the system user designates the information for storage.

A second technique that can be used for forwarding messages or instructions to a user does not require the system user to select a menu item requesting transmission by clearinghouse **54** of messages that have been stored for forwarding to that user. In particular, clearinghouse **54** can be programmed to operate in a manner that either automatically transmits stored messages for that user when the user operates the system of FIG. **1**A or FIG. **1**B to send information to the clearinghouse or programmed to operate in a manner that informs the user that messages are available and allows the user to access the messages when he or she chooses to do so.

Practicing the invention in an environment in which the healthcare professional uses personal computer in some or all of the above-discussed ways can be very advantageous. On the other hand, the invention also provides healthcare professionals timely information about system users without the need for a computer (**62** in FIG. **2**) or any equipment other than a conventional facsimile machine **55** in FIGS. **1** and **2**. Specifically, information provided to clearinghouse **54** by a system user **58** can be sent to a healthcare professional **60** via telephone line **68** and facsimile machine **55**, with the information being formatted as a standardized graphic or textual report **56**. Formatting a standardized report **56** (i.e., analyzing and processing data supplied by blood glucose monitor **16** or other system monitor or sensor) can be effected either by data management unit **10** or within the clearinghouse facility **54**.

A preferred embodiment of the invention is focused on sending the patient an educational program corresponding to an educational need as assessed by the system of the invention. The adaptation of the system of FIGS. **1** and **2** for this purpose is shown in detail in FIGS. **3**–**15**.

FIG. **3** shows the main components of a health management system for remotely monitoring a patient and for

training the patient to comply with a treatment plan for a health condition. A healthcare clinic **100** has a clinic server computer **120** that includes a mail server application **140** for managing electronic mail services for clinic **100**. Clinic server **120** also includes a master patient database **180** for storing data relating to each patient managed by clinic **100**. Clinic server **120** further includes a data management server application **160** for managing and performing database operations taking place on master patient database **180**. Clinic server **120** is coupled to a modem M1 for connecting server **120** to a communication network **280**.

A clinician computer **200** is networked to clinic server **120**. Clinician computer **200** has a clinician mail client application **220** for composing, sending, and receiving electronic mail messages. Clinician computer **200** further includes a local clinician database **260** for storing patient data downloaded from clinic server **120**. Clinician computer **200** also has a clinician data management application **240** for managing patient data stored in local clinician database **260**. Clinician computer **200** is coupled to a modem M2 for connecting clinician computer **200** to communication network **280**.

A patient computing device **320** for collecting patient data relating to the patient's health condition is located at a patient site **300**, typically the patient's home. In the preferred embodiment, patient computing device **320** is a personal computer having a display monitor. However, in alternative embodiments, patient computing device **320** may be any information processing and display unit, such as a network terminal, a television set with a set-top cable converter box, a personal digital assistant, or a video educational program system as described above.

Patient computing device **320** includes a patient mail client **340** for sending and receiving electronic mail messages. Patient computing device **320** further includes a local patient database **400** for storing the patient data and a data management application **380** for managing the patient data stored in database **400**. Patient computing device **320** is coupled to a modem M4 for connecting patient computing device **320** to communication network **280**.

A metering device **420** is connected to patient computing device **320**. Device **420** is for measuring a physical characteristic of the patient's health condition, such as blood glucose levels for a diabetic patient or peak flow rates for an asthmatic patient, and for uploading the measurements to computer **320**. Specific techniques for connecting a metering device to a patient computing device for remote monitoring of a patient are well known in the art.

An on-line information service **440** having educational documents **460** is connected to communication network **280** through a modem M4. In the preferred embodiment, on-line information service **440** is a world wide web service having educational documents **460** located on a world wide web site, such as the American Diabetes Association's web site or the American Lung Association's web site. Of course, there are many other on-line services such as Compuserve, America On-Line, and other electronically accessible database servers that may be used as a source of educational documents in alternative embodiments.

An educational video educational program **360** for training the patient to comply with a treatment plan for his or her health condition is installed on patient computing device **320**. In the preferred embodiment, educational video educational program **360** is a Health Hero® video educational program, such as Packy & Marlon®, commercially available from Health Hero Network, Inc. of Mountain View, Calif. Educational video educational program **360** is preferably a role-playing educational program that permits a patient to simulate treating his or her health condition. Educational program **360** is further capable of scoring patient responses to the role-playing program to determine the patient's knowledge, comprehension, and attitude in complying with the treatment plan for his or her health condition.

For example, in the educational video educational program Packy & Marlon®, one or two players manage the diabetes of two educational program characters and attempt to progress to higher educational program levels through successful management of the diabetes. Diabetes management steps in the educational program include selecting appropriate foods, taking insulin doses, measuring blood glucose levels, and answering questions about diabetes. Educational program responses are recorded in several categories to indicate the player's knowledge, comprehension, and attitude in managing diabetes. A player's attitude may also be determined by recording whether the player played alone or with a friend, indicating if the player is adjusting socially to his or her health condition.

FIG. **4** is a schematic block diagram illustrating the entering of patient data relating to the patient's health condition into local patient database **400**. The patient data includes educational program response information **500** derived by scoring patient responses to educational video educational program **360**. Educational program response information **500** includes a knowledge score **530**A for indicating the patient's understanding of the treatment plan. Educational program response information **500** also includes a comprehension score **530**B for indicating a cognitive ability of the patient to understand an educational program designed to teach compliance with the treatment plan. Educational program response information **500** further includes an attitude score **530**C for indicating the patient's attitude toward complying with the treatment plan. The patient data further includes device measurements **540** received from metering device **420** and logbook records **520** of the patient's treatment plan. Logbook records **520** are entered into database **400** using a logbook program **480** included in patient data management application **380**.

FIG. **5** shows a sample logbook entry screen **560** of logbook program **480** as it appears on patient computing device **320**.

Screen **560** illustrates a typical logbook entry for a diabetic patient. Screen **560** includes a date field **580** and a time field **600** for selecting a specific blood glucose reading **620** from device measurements **540**. Screen **560** further includes four radio buttons **640**. Each radio button **640** is designed to display a list of events in a list box **660**. List box **660** contains a selected event **680** that has been chosen by the patient as the appropriate event corresponding to blood glucose reading **620**. Screen **560** also has a notes field **710** for free form entry of other information relating to the patient's treatment plan.

Screen **560** also includes an add medication button **720** for displaying an add medication screen **800**, as shown in FIG. **7**. Screen **800** includes a list box **810** listing diabetes medications. List box **810** contains a selected medication **820** that has been chosen by the patient. Screen **800** also includes a dosage field **840** for recording a medicine dosage. An OK button **860** and a CANCEL button **880** are for confirming and canceling, respectively, the information entered in screen **800**.

Referring again to FIG. **5**, a medication field **700** shows the information entered in add medication screen **800**. An

OK button **740** and a CANCEL button **760** are for confirming and canceling, respectively, the logbook information entered in screen **560**. FIG. **6** illustrates a sample logbook entry screen **780** for an asthmatic patient. FIG. **8** shows a sample add medication screen **900** for the asthmatic patient. The design and use of such a logbook program for entering logbook records **520** into database **400** are well known in the art.

Referring to FIG. **9**, clinician data management application **240** includes a clinician data view program **920** for analyzing patient data to determine an educational need of the patient in learning to comply with his or her treatment program. Data view program **920** is capable of displaying a selected subset of device measurements **540** and logbook records **520** in graphical form.

FIG. **10** shows a data view **980** produced by data view program **920** on the screen of clinician computer **200**. Data view **980** is a sample data view of a diabetic patient's data. Data view **980** includes a selected subset **101** of device measurements **540** and logbook records **520** corresponding to one day in the patient's treatment plan indicated by a date field **103**. Data view **980** further includes a graph **102** of selected subset **101**. A set of control buttons **104** allow the clinician to scroll through different days or weeks of the patient's data to quickly view selected subsets from different days. FIG. **11** shows a sample data view **106** for an asthmatic patient's data. Specific techniques for creating a data view program to display data in this manner are well known in the art.

Referring again to FIG. **9**, patient data management application **380** includes a patient data view program **960** having the same functionality as clinician data view program **920**. Thus, patient data view program **960** is also capable of displaying data views **980** and **106** on patient computing device **320**. Application **380** further includes a document view program **970** for displaying an educational document retrieved from on-line information service **440**, as will be explained in the operation section below.

Clinician mail client **220** is of the type that allows a user to compose an electronic mail message containing an embedded pointer to a selected program installed on patient computing device **320**. Mail client **220** further allows the pointer to be represented in the message as an icon. The pointer may optionally include specific data and instructions to be executed by the selected program or point to an address that has a set of instructions to be executed by the program. Patient mail client **340** is of the type that allows a user to start the selected program on patient computing device **320** by selecting the icon in the electronic mail message. A suitable electronic mail program for performing these functions is Microsoft Exchange™ commercially available from Microsoft Corporation of Redmond, Wash. The programming of an electronic mail application to perform these functions is well known in the art.

FIG. **12** illustrates a sample electronic mail message **940** in detail. Message **940** contains an icon **110** that includes an embedded pointer to patient data view program **960**. Icon **110** further includes patient data from a specific date and instructions for program **960** to display the patient data in graphical form. An alternative electronic mail message **112** is illustrated in FIG. **13**. Message **112** contains an icon **114** that includes an embedded pointer to educational video educational program **360**. Icon **114** further includes instructions for video educational program **360** to execute Fig educational program level two. A third electronic mail message **121** is illustrated in FIG. **14**. Message **121** contains an icon **122** that includes an embedded pointer to document view program **970**. Icon **122** further includes an educational document retrieved from on-line information service **440** and instructions for program **970** to display the educational document.

The operation of the preferred embodiment is illustrated in FIG. **15**. FIG. **15** is a flow chart showing a preferred method of using the health management system for remotely monitoring a patient and for training the patient to comply with a treatment plan for his or her health condition. In step **202**, the patient is tested with metering device **420** to produce device measurements **540**. Typically, the test is self-administered by the patient. Next, measurements **540** are uploaded to patient computing device **320**, step **204**, and stored in local patient database **400**.

Once device measurements **540** are stored in database **400**, the patient enters logbook records **520** into database **400** using logbook program **480**, step **206**. Additionally, the patient plays educational video educational program **360**, entering educational program responses into patient computing device **320**. As the patient plays video educational program **360**, the patient's educational program responses are scored to produce knowledge score **530A**, comprehension score **530B**, and attitude score **530C**. Knowledge score **530A**, comprehension score **530B**, and attitude score **530C** are stored as educational program response information **500** in database **400**, step **208**.

Next, educational program response information **500**, logbook records **520**, and device measurements **540** are transmitted through communication network **280** to clinic server **120** and stored in master patient database **180**, step **210**. In a typical implementation, clinic **100** manages the healthcare of hundreds of patients and the data for each patient is stored in master patient database **180**. A clinician at clinician computer **200** downloads patient data of a particular patient for whom he or she is responsible from master patient database **180** to local clinician database **260**, step **212**.

The downloaded patient data is analyzed in clinician computer **200** using clinician data view program **920**, step **214**. As shown in FIG. **10**, data view program **980** displays on clinician computer **200** graph **102** of selected subset of data **101**. The clinician also analyzes knowledge score **530A**, comprehension score **530B**, and attitude score **530C** to assess the patient's psychological state. Based on analysis of the patient data, the clinician determines an educational need of the patient for learning to comply with a treatment program, step **216**. A first example of such an educational need is illustrated in FIG. **12**. As indicated in electronic mail message **940**, the clinician has determined that the patient needs to learn the health consequences of failing to eat balanced meals in a diabetes treatment plan.

A second example of an educational need is illustrated in FIG. **13**. As indicated in electronic mail message **112**, the clinician has determined that the patient needs to learn the importance of taking medication. A third example of an educational need is illustrated in FIG. **14**. As indicated in electronic mail message **121**, the clinician has determined that the patient needs to learn how to treat diabetes while traveling. Of course, these are just a few examples of possible educational needs of the patient. The clinician may identify many other educational needs, such as the patient's need to learn coping skills, communication skills, and other social adjustment factors.

Once the clinician has determined the patient's educational need, he or she selects an educational program cor-

responding to the educational need, step **218**, and embeds in an electronic message a pointer or a prompt to the educational program, step **221**. The program will execute when the patient selects the pointer or reponds to the prompt. In the preferred embodiment, the educational program is selected to be either patient data view program **960**, educational video educational program **360**, or document view program **970** depending on the educational need determined by the clinician.

FIG. **12** shows an example of the clinician selecting data view program **960** as the educational program. The clinician embeds a pointer to program **960** in icon **110**. The clinician further loads icon **110** with patient data from a specific day and instructions for program **960** to display the patient data in graphical form. FIG. **13** shows an example of the clinician selecting a educational program level of educational video educational program **360** as the educational program. The clinician embeds a pointer to the selected educational program level of video educational program **360** that has an educational content corresponding to the patient's educational need. FIG. **14** shows an example of the clinician selecting document view program **970** as the educational program. The clinician embeds a pointer to program **970** in icon **122**. The clinician further loads icon **122** with an educational document retrieved from information service **440**.

Next, the electronic message containing the embedded pointer is transmitted from clinician computer **200** to patient computing device **320** through mail server **140** and communication network **280**, step **222**. The selected educational program is then started on the patient computing device by selecting the embedded pointer in the electronic mail message, step **224**, typically by clicking the icon in which the pointer is embedded with a mouse or pointing device.

As the patient works with the educational program, he or she continues the feedback loop with the clinician, step **226**, by returning to step **202** and repeating the method described. With this continuous feedback loop between the patient and clinician, the clinician is able to monitor the patient's progress and effectively train the patient to comply with the treatment plan.

SUMMARY, RAMIFICATIONS, AND SCOPE

Although the above description contains many specificities, these should not be construed as limitations on the scope of the invention but merely as illustrations of the presently preferred embodiment. Many other embodiments of the invention are possible. For example, in one alternative embodiment, the clinic server is eliminated from the system so that the clinician computer exchanges information directly with the patient computing device. The clinic server is presently preferred for performing resource intensive operations, such as storing large amounts of patient data, but the clinic server is not necessary to enable the system and method of the invention. In embodiments that include the clinic, server, the clinic server need not be physically located at the clinic. The server may be located off-site and networked to the clinician computer.

Additionally, the preferred embodiment describes the use of modems for connecting the various computers in the health management system to the communication network. However, it is obvious that many other types of connections may be employed, such as ethernet connections. Specific techniques for networking computers are well known in the art.

Further, the logbook entry screens illustrated are exemplary of just one possible embodiment of the invention. In alternative embodiments, the logbook entry screens and logbook records include fields for entering and storing other health-related parameters, such as the patient's dietary intake and exercise routines. Similarly, the data views illustrated are exemplary of just one possible embodiment. Many other data views are possible, such as weekly views of the patient's data, trend graphs of the patient's data, and calendar views of the patient's logbook records.

Although the preferred embodiment describes a system and method for training patients having diabetes or asthma, the invention is not limited to patient's with these diseases. The system and method of the invention are equally effective for training patients to comply with treatment plans for other health conditions, such as cardiovascular diseases, high blood pressure, mental health conditions, addictions, or diet and exercise problems.

Therefore, the scope of the invention should be determined, not by examples given, but by the appended claims and their legal equivalents.

I claim:

1. A method for remotely monitoring a patient and for training the patient to comply with a treatment plan for a health condition, the method comprising the following steps:

a) entering in a patient computing device data relating to the health condition;

b) transmitting the data from the patient computing device to a clinician computer via a communication network;

c) analyzing the data received in the clinician computer to determine an educational need of the patient;

d) selecting in the clinician computer an educational program corresponding to the educational need;

e) transmitting an electronic message from the clinician computer to the patient computing device, wherein the electronic message contains an embedded pointer to the selected educational program; and

f) starting the educational program on the patient computing device by selecting the embedded pointer in the electronic message.

2. The method of claim **1**, wherein the educational program comprises an educational video program.

3. The method of claim **1**, wherein the educational program comprises questions.

4. The method of claim **3**, wherein patient answers to the questions are sent to the clinician computer to create and update a patient database.

5. The method of claim **1**, wherein the educational program comprises a patient data view program for displaying a selected subset of the data in graphical form.

6. The method of claim **1**, wherein the educational program comprises a document view program for displaying an educational document.

7. The method of claim **6**, wherein the educational document is retrieved from an on-line information service connected to the communication network.

8. The method of claim **1**, wherein the embedded pointer to the educational program comprises an icon.

9. The method of claim **1**, wherein the data comprises measurements of a physical characteristic of the health condition and wherein the entering step comprises:

a) testing the patient with a metering device to produce the measurements; and

b) uploading the measurements from the metering device to the patient computing device.

10. The method of claim **1**, wherein the data comprises records of the treatment plan and wherein the records are

entered in the patient computing device using a logbook program installed on the patient computing device.

11. The method of claim 1, wherein the data comprises information derived from patient responses to an educational video program played on the patient computing device and wherein the patient responses are entered by the patient while playing the educational video program.

12. The method of claim 11, wherein the information derived from the patient responses comprises a comprehension score for indicating a cognitive ability of the patient to understand the educational video program.

13. The method of claim 11, wherein the information derived from the patient responses comprises a knowledge score for indicating the patient's understanding of the treatment plan.

14. The method of claim 11, wherein the information derived from the patient responses comprises an attitude score for indicating the patient's attitude toward complying with the treatment plan.

15. The method of claim 1, wherein the data is analyzed by a clinician using a clinician data view program on the clinician computer.

16. A system for remotely monitoring a patient and for training the patient to comply with a treatment plan for a health condition, the system comprising:

a) a patient computing device for collecting data relating to the health condition;

b) a clinician computer having an analysis means for analyzing the data to determine an educational need of the patient, the clinician computer further having a message means for composing an electronic message containing an embedded pointer to an educational program that corresponds to the educational need; and

c) a communication network for connecting the patient computing device to the clinician computer and for transmitting the data and the electronic message therebetween;

wherein the patient computing device further has a means for starting the educational program when the patient selects the embedded pointer in the electronic message.

17. The system of claim 16, wherein the educational program comprises an educational video program played on the patient computing device.

18. The system of claim 16, wherein the educational program comprises a patient data view program for displaying a selected subset of the data in graphical form.

19. The system of claim 16, wherein the educational program comprises a document view program for displaying an educational document.

20. The system of claim 16, wherein the analysis means comprises a clinician data view program for displaying a selected subset of the data in graphical form.

21. The system of claim 16, wherein the embedded pointer to the educational program comprises an icon.

22. A method for remote patient monitoring and remote patient training using a computer system, the computer system comprising a clinician computer, a patient computing device having an educational program loaded thereon, and a communication network connecting the clinician computer to the patient computing device, the method comprising the following steps:

a) entering in the patient computing device data relating to a health condition of a patient;

b) transmitting the data from the patient computing device to the clinician computer via the communication network;

c) analyzing the data received in the clinician computer to determine an educational need of the patient;

d) selecting a segment of the educational program having an educational content corresponding to the educational need;

e) transmitting an electronic message from the clinician computer to the patient computing device, wherein the electronic message contains an embedded pointer to the selected segment; and

f) starting the educational program on the patient computing device at the selected segment by selecting the embedded pointer in the electronic message.

23. The method of claim 22, wherein the data comprises measurements of a physical characteristic of the health condition and wherein the entering step comprises:

a) testing the patient with a metering device to produce the measurements; and

b) uploading the measurements from the metering device to the patient computing device.

24. The method of claim 22, wherein the data comprises records of a treatment plan for the health condition and wherein the records are entered into the patient computing device using a logbook program installed on the patient computing device.

25. The method of claim 22, wherein the data comprises information derived from patient responses to the educational video program and wherein the patient responses are entered in the patient computing device by the patient while playing the educational video program.

26. The method of claim 25, wherein the information derived from the patient responses comprises a comprehension score for indicating a cognitive ability of the patient to understand the educational video program.

27. The method of claim 25, wherein the information derived from the patient responses comprises a knowledge score for indicating the patient's understanding of the treatment plan.

28. The method of claim 25, wherein the information derived from patient responses comprises an attitude score for indicating the patient's attitude toward complying with the treatment plan.

29. The method of claim 22, wherein the embedded pointer to the selected segment comprises an icon.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,960,403
DATED : September 28, 1999
INVENTOR(S) : Stephen J. Brown

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page,
Related U.S. Application Data is amended as follows:
-- Continuation-in-part of application No. 08/481,925, Jun. 7, 1995, Pat. No. 5,899,855, which is a continuation of application No. 08/233,397, Apr. 26, 1994, now abandoned, which is a continuation-in-part of application No. 07/977,323, Nov. 17, 1992, Pat. No. 5,307,263, and a continuation-in-part of application No. 08/666,242, Jun. 20, 1996, abandoned. --

Column 7,
Line 22, the word "persona:" should be -- personal. --
Line 27, the word "with" should be -- With. --

Column 15,
Line 65, the word "Fig" should be deleted.

Signed and Sealed this

Twenty-third Day of April, 2002

Attest:

Attesting Officer

JAMES E. ROGAN
Director of the United States Patent and Trademark Office